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Fish Men Discover
a 2,200-year-old Greek Ship
CAPT. JACQUES-YVES COUSTEAU

With Map-diagram and 43 Illustrations, 29 in Natural Colors

Amid the Mighty Walls of Zion 37

With Map and 27 Illustrations
25 in Natural Colors

LEWIS F. CLARK
JUSTIN LOCKE

Man's New Servant, the Friendly Atom

With 16 Illustrations

F. BARROWS COLTON 71
VOLKMAR WENTZEL

Westminster, World Series of Dogdom 91

With 32 Illustrations
28 in Natural Colors

JOHN W. CROSS, JR.

The Explosive Birth of Myojin Island 117

With Map and 16 Illustrations

ROBERT S. DIETZ

Cliff Dwellers of the Bering Sea 129

With Map and 15 Illustrations
10 in Natural Colors

JUAN MUÑOZ

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Fish Men Discover a 2,200-year-old Greek Ship

BY CAPT. JACQUES-YVES COUSTEAU

Leader of the National Geographic Society-Calypso Marine Archeological Expedition

Since April, 1952, the National Geographic Society has been cooperating with Capt. Cousteau in his remarkable undersea explorations. His first report as leader of the National Geographic Society-Calypso expeditions, "Fish Men Explore a New World Undersea," appeared in the October, 1952, NATIONAL GEOGRAPHIC, a few months before publication of his best-selling book *The Silent World*. Here he tells of an even more extraordinary achievement.—The Editor.

HUSTLING, noisy Marseille, the second city of France and a cosmopolitan port since the 6th century before Christ, is a swarm of life on a barren and savage coast.

South of the city is the rugged massif called Marseillevyre, presenting to mariners a desolate, jagged chain of stark Urgonian limestone, repeated offshore by the deserted islands of Maire, Jarron, Jaire, and Rion. The peaks fold into the sea like layer cakes that have fallen on their sides.

The last island to the east is a stone iceberg called Grand Congloué, skinned by our Mediterranean *mistral*s and chewed into fantastic shapes by swell. It is the landscape of Tierra del Fuego placed 10 miles from a world-important harbor.

Rock Awakes to Strange Activity

In August of 1952 this inhospitable rock, 500 feet long by 325 feet wide, became a center of activity that amazed the fisherfolk. Skippers passing the rock saw the familiar lighthouse tender *Lionel Freanel* laying heavy cruiser buoys offshore. Then our white oceanographic research ship, *Calypso*, formerly of the United States Navy, steamed into the surf and clung to the buoys, riding, it seemed, into the cliff itself. There it hung at its acrobatic mooring through the endless easters and

mistral's of that summer, while inquisitive flotillas of barks, lateen-rigged sailboats, yachts, and power cruisers stood off and watched.

The floating audience next witnessed a detail of Army engineers landing from launches and scaling the sides of Grand Congloué like alpinists to build big platforms on the cliff. Engines and equipment went on breeches buoys to the platforms, and *Calypso* slung an 85-foot wooden boom from a cemented socket in the limestone, guyed it off, and ran pipes and cables out on the crane (page 2).

At length a house was perched on the sloping shelf, a tin house painted yellow, from which the fishermen going past at dawn and sunset saw the glow of electric lights.

In the daylight small human figures scurried from the house to a ladder and went down the cliff to the engine platform, from which came a clatter of machinery that resounded across the sea. Aqualung divers up-ended themselves all day long and vanished into the depths, with a flicker of foot fins. Occasionally a man fired a rifle into the water to recall the divers, and then the ship hoisted heavy baskets full of objects the colors of orange lead paint, green algae, and mud.

The fishermen deduced that one of the lines hanging from the long boom was a suction pipe which spat water and debris into a filter



Diver Nicot Walks the "Plank," an 85-foot Wooden Boom

Beneath the spar lies a Greek ship that sank around 250 B. C. Strung between Calypso and a cement socket ashore, the boom supports a suction hose (opposite page) designed to sweep the wreck's debris in vacuum-cleaner fashion (page 3).

✦ This broken wine jar waited 2,200 years for the groping hand of the masked explorer. Tanks of compressed air on his back enable the Aqualunger to breathe.

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♦ *Calypso* Lowers a Flexible Pipe to Suck Up Greek Relics.

A Marseille commercial diver crippled by the bonds revealed to Frédéric Dumas his secret of a hidden colony near a heap of old pots sunk off the Mediterranean island of Grand Congloué. Suspecting that the pots were in reality ancient wine jars, Dumas and Capt. Jacques-Yves Cousteau moved out in *Calypso*, research ship of the National Geographic Society-*Calypso* Marine Archaeological Expedition, and explored the bottom. Cousteau on his first dive spotted the wreck, which the silt of 22 centuries had mounded up.

Aqualung divers have removed tons of mud from the sunken vessel. The first year they raised more than 3,000 amphorae, or wine jars, and a fine collection of black Campanian dinner dishes. Only the stern hold has been fully cleared (page 11).

More than 100 feet long, the ancient cargo carrier is the largest of its period ever found virtually intact.

© Kodachrome by Jacques-Yves Cousteau and Frédéric Dumas

3



basket up on a rock. Such a workshop, such insensate human activity and roar of engines in this forlorn, sea-beaten place, had only one explanation for the fishermen. They shook their heads and said, "It is a fabulous treasury. The gold is piling up in their holds!"

Our good friends the fishermen are partly right. Our ship *Calypso* is working a treasure argosy, laden with at least a million pounds of things—things of no commercial value, yet priceless to us. Instead of bullion and the jewels of Ind, we are bringing to light a newspaper filler story of antiquity, the sort of thing that might have drawn passing comment in the market places of Athens or Syracuse when it happened around 230 B. C.:

"Well, I hear Marcus Sestius lost his big wine ship. I wonder whether he'll be able to finish that fancy house he is building at Delos."

Almost 2,200 years later we are putting this back-page item into today's headlines.

A Sail, Not Oars, Sped This Argosy

The ill-fated ship was enormous, too big for rowers and therefore not properly a galley. She probably carried a great single mast and a sail of sewn bullhides. She left the merchant port of the sacred isle of Delos (Dhilos), birthplace of Apollo, in the Cyclades Islands, laden with Aegean wine stored in the graceful fat-bellied earthenware jars the Greeks called amphorae. Because she was to take cargo in western ports of call, the wine jars were stowed lowermost, under the heavy lead-plated main deck.

The ship sailed west through the friendly Greek islands (map, page 11). The next one was always in sight to comfort the navigator. Then she took the dreaded plunge across the Ionian Sea, open water that might mean 20 days out of sight of land, or four if the ship was blessed by Poseidon, god of the sea. When the coast of Italy was raised, land could be followed for the rest of the way.

The great ship passed the Strait of Messina between Sicily and Italy, avoiding the whirlpool of Charybdis and the rock of Scylla. She put into a port northwest of what is now Naples, one of the busy harbors in the Gulf of Gaeta, and took on a tremendous loading of black-varnished export dinnerware, which Greek potters were then bringing into mass production in their settlements in Italy. This cargo was stowed below with the Greek wine.

The main deck was loaded three deep with slender Roman amphorae, each containing

several gallons of red Latium wine. Quite probably it was produced by Lucius Titius, of a well-known wine-growing family in the Sabina hills near Rome.

Rome was not very important in those days, but it paid an Italian-born shipowner like Marcus Sestius to look for cargo in the busy new colonies the Greeks had established in Italy. The Greeks in Massalia (Marseille) would pay excellent prices for the dinnerware and would bid high for the home-grown wine. It was valuable; you could trade an amphora of wine for a slave, for viticulture was only beginning in France.

So the ship set out into the Tyrrhenian and Ligurian Seas. She was overloaded; doubtless the owner wanted a big return, and the master, as masters must, sailed an argosy he knew was dangerously low in the sea. At all events, the ship reached the savage coast under Marseillevéyre, only to sink at once into a pocket of rock under Grand Congloué, almost within sight of Massalia. She may have struck the sharp eastern cape, or the crew may have sailed the swamping ship there to save themselves, or all hands may have been tipsy from sampling the ship's cargo.

The riddle of this wreck and some notes on the blank pages in the history of commercial navigation are the treasures we seek at Grand Congloué. In the wreck there may be a "pursuer's safe," full of bronze or silver coins, which will come up one day in the suction pipe or in the hands of one of our swimmers. If it does, the coins will merely furnish supplementary data on the age and itinerary of the vessel.

Vessel Plunges to Her Last Berth

The ship sank slowly along the submerged cliff, past glorious gorgonian fans, some of the most beautiful we have seen in the sea.

Marcus Sestius' freighter sank upright, landing keel down on a sloping shelf of rock, the pedestal of Grand Congloué. Her stern, counter, and captain's house probably crumpled away against the rock on the way to the bottom. She rested with her bow pointing back toward the sacred isle of Apollo and her stern framed in a wide recess almost designed to fit her lines. The depth at her stern was 112 feet, and the ship fell away at a 20-degree angle toward a depth of 140 feet at the bow. In the fall her catted starboard anchor caught on a ledge 65 feet down (drawing, page 11).

The sea adopted the wreck. Fortunately for future diggers, the ship's depth and the



A Flipped Diver at 140 Feet Hammers Debris to Fit the Suction Pipe

Toiling in the wreck's cold, dim graveyard, the Aqualunged excavator must make every second count. At 140 feet he can work actively for only 17 minutes without having to undergo decompression at stages on his way up. A cloud of exhaust bubbles above his head provides silvery evidence of his thirst for air. When the echo of a rifle shot reaches him through the water, he knows his shift is over. Rubber-finned feet beating rhythmically, he then heads for safety. A slim tube attached to the suction pipe carries compressed air to a valve near the diver's left hand. Shooting into the hose, the air stream sucks water, mud, and debris to a strainer on the surface.



Angry Seas Attack the Engine House on Grand Congloué

Few men visited this barren rocky island until Captain Cousteau's salvage team clambered ashore in August, 1953. Rigging a precarious platform against the rocks, they installed engines to run their suction hose (pages 1 and 2).

A winter storm crushed the first working platform. But Cousteau built a heavier one and added a ladder leading up the cliff to a tin shack, which the divers christened Port Calypso (page 12). They decked their snug quarters with ancient wine jars and dishes.

Divers Descend into the Depths

When the furious wind scours the Mediterranean, *Calypso* anchors off Grand Congloué at her peril. But diving goes on from the island itself, Aquaboners dropping into the sea from a block and tackle attached to a boom. Once below the surface, they feel little of the ocean's surp and swell.

James F. Galt

limestone walls that embraced her prevented the wreck from being scattered in the swell and surf off the island.

Worms attacked the wood, but the ancient shipwrights had armored the entire hull and decks in lead sheathing $\frac{1}{16}$ of an inch thick and fastened it to the hull every three inches with copper nails. The first worms fell back, frustrated, leaving the banquet to future generations that found the sheathing loosened and the hull vulnerable.

The second attack was by sponges, ascidians, and sea urchins, which settled on the leaden plates and amphorae spilled in the crash. These creatures attracted agile fish, which investigated the newcomers. Octopuses writhed along the rocks to take up homes in the empty amphorae. The cephalopods drew broken dishes, pebbles, and shells to the mouths of the jars to make outer defenses.

Mud fell like snow. It was sand pulverized from the limestone walls, sparse silt that rain scoured from the rock, and fossil mud, the skeletons of generations of trillions of small marine animals that fell on the ship. The man-made thing was settling into the sea and becoming part of it.

Under the weight of little skeletons, the already overloaded main deck sprang its knees and collapsed into the Greek amphorae and Campanian dishes in the bilge, ejecting this original cargo through the port quarter down the slope into the deep. The ship's flank opened slowly; it may have taken as long as 200 years.

Wreck Covers 10,000 Square Feet

The mud falling, falling, falling, while Christ was briefly alive, through the short flourish of Imperial Rome, to the age of Constantine, then the Middle Ages, covered the wreck and preserved it against the destruction these natural processes had started.

Then, quite recently, perhaps while Prince Henry the Navigator and Magellan were discovering the extent of the world, great boulders were loosened from the heights of Grand Congloué and tumbled into the sea. Three dozen rocks, two of which weighed 10 and 12 tons, doubly buried the ship, as if to hide the drama forever. Oddly enough, the cushioning effect of water brought boulders to rest on top of amphorae without breaking them.

In modern times the wreck became a tumulus, a big bump on the sea bottom, about 10,000 square feet in area. It consisted of mud, potsherds, and pebbles from which pro-

truded the immortal amphorae, somehow riding on the mound as it was built. A few necks of amphorae stuck up, and vague broken suggestions of pots, howls, cups, and dishes were visible in the deep (page 8).

How did we ever stumble upon this well-buried prize? We learned of it from a hospital bed.

A Diver Discloses His Secret

In Marseille there was a free-lance Aqualung diver named Christianini who made a lonely living taking scrap metal and other oddments off the floor and who knew the bottom east of Marseille like the back of his sun-bronzed hand. One day Christianini dived too deep and too long and was carried ashore with legs paralyzed from an attack of the bends. The nitrogen bubbles were clogging his nervous and respiratory centers when he was rushed to the Navy's Undersea Research Group at Toulon, to which Frédéric Dumas—my old comrade and assistant chief of *Calypso* expeditions—is attached as a civilian expert.

Three Navy doctors recompressed Christianini in a steel chamber and decompressed him for two days. His life was saved, but Christianini had to remain six months in the hospital, and his toes had to be amputated. Dumas visited him weekly.

In gratitude Christianini said one day: "You know, Dumas, we divers never tell our secrets. But I won't be able to go down again, and I want to tell them to you."

Dumas took notes on the outpouring. Christianini dwelt enthusiastically on an incredible colony of lobsters that lived along the submarine walls of Grand Congloué. Dumas asked him what the landmarks were.

"A big natural stone arch a hundred feet down, off the western cape of the island," Christianini replied. "You can tell where the lobsters are when you see the old pots. Just follow up above, and you'll see the lobsters."

The pots, Dumas found through interrogation, were ancient amphorae. Christianini had seen so many amphorae that they were a bore. He wanted Dumas to know where to find lobsters.

As it happened, Dumas and I were soon to be in a position to follow up Christianini's tip. We had the use of our own research ship, *Calypso*, and I had been detached by the French Navy to organize oceanographic research with a civilian team. Our first shake-down cruise with a party of scientists had taken us to the Farasan Bank in the Red Sea



Ancient Amphorae . . .

Stacked in rows along the buried deck of their cargo ship, these jars once held the resin-flavored wine of the Greek Cyclades and the red wine of the Sabine hills near Rome. Cousteau, sampling wine from one of the few amphorae whose seals remained intact, found that either the years had been unkind or the ancients' taste had been peculiar.

Why did the Marseille-bound vessel founder only a few miles from her destination? One possible explanation, deduced from the many pierced wine jars, is that the crew may have become tipsy and run the ship aground.

♦ Albert Falco, serving as an upside-down stevedore, stows jars in the salvage net.

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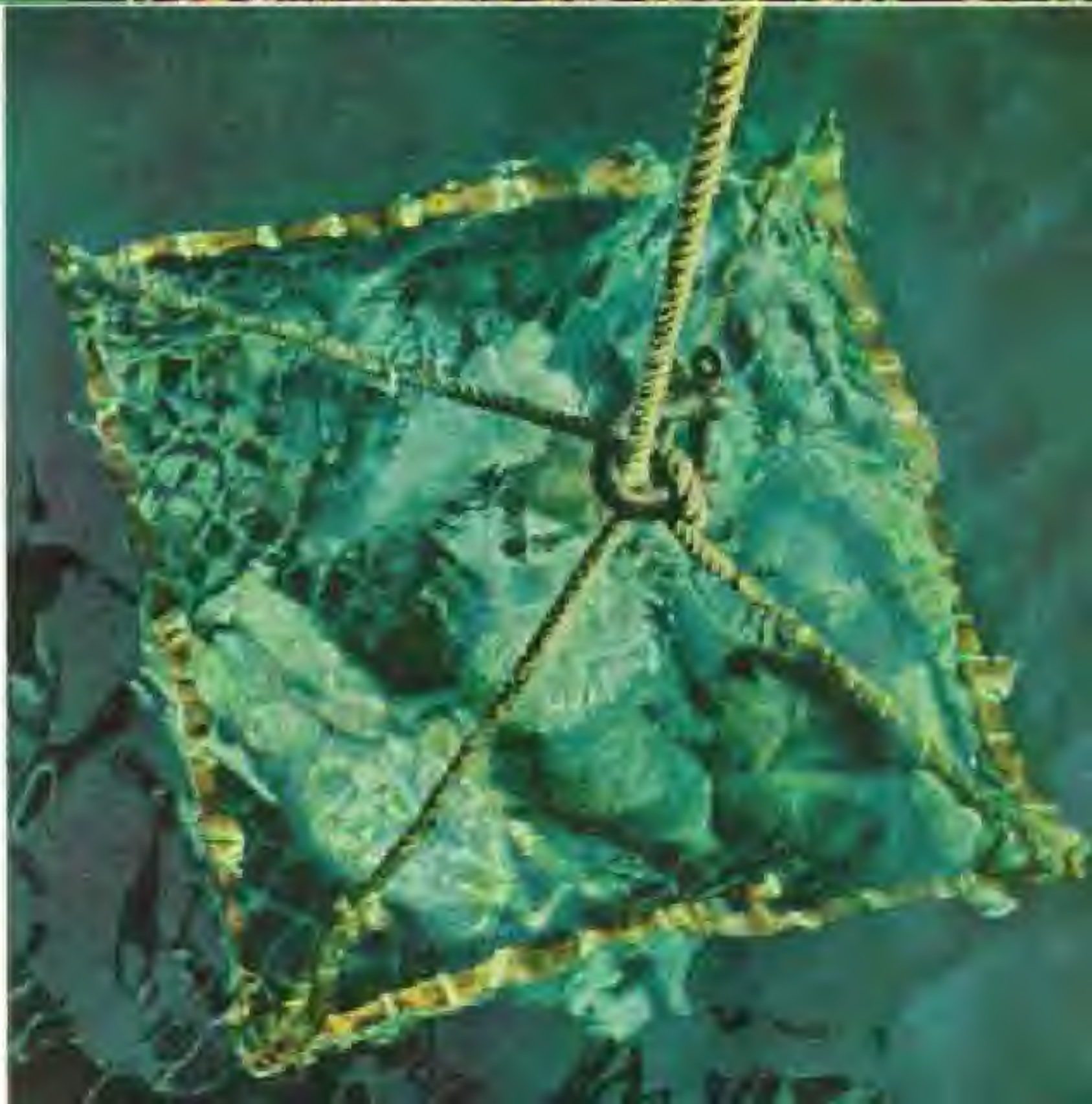


...Rise from the Mud

Standard container for the ancient wine trade, the terra-cotta amphora held five to seven gallons. A cargo ship's capacity was measured not in tons but in amphorae. The wreck of Grand Congloué is reckoned a 10,000-jar ship.

Costeau's divers discovered most of the unsealed jars filled with pebbles, shells, and silt dragged in by octopuses to furnish their earthenware apartments. Packed with such debris, an amphora might weigh 100 pounds. Some jars broke loose when the suction pipe swept away their mantle of dirt. Others, cemented in limestone sediment, had to be pried up with crowbars.

✦ A basket of amphorae nears the surface and (above) arrives on deck.



in the winter of 1951-52. By the middle of August we were free to investigate some of the wrecks Dumas had enthusiastically lined up.

Our top objective was a sunken vessel known to be of the first century B. C., lying 140 feet down under Maire Island. But on the way we decided to take a look at those "pots" off Grand Congloué. On board we had Prof. Fernand Benoit, Director of Antiquities of Provence and head of Marseille's Archeological Museum in the Château Borély, so that we could get a quick archeological check on anything we found.

Constans Discovers the Argosy

Dumas was the first to harness up and go below. He quickly located the majestic natural arch of limestone. But there were no pots under it. Professor Benoit was a little impatient with this digression when Dumas surfaced with nothing to report.

I thought we had better look twice. I went down off the eastern cape, exactly below the spot where our archeological filter dump is now located. Had I turned a few yards to the west, I would have swum right into the ancient wreck. But my plan was to round the cape toward the south, against the syncline, and scan the cliff thoroughly.

I went slanting down past lovely coral shelves and grottoes to a deeper descent along a sandy slope at the foot of the rock. I reached 220 feet without seeing a single amphora and then doubled back around the fateful cape, growing tired and much disappointed.

At 200 feet I found an amphora. I was excited and looked all around, but there was no other. A single amphora is an accident; there can be no ship fallen there. I took the amphora and punched it upright into the sand to make a landmark and then hurriedly ascended. The dive was getting too long, deep, and dangerous.

Sixty feet up, I came upon the wreck. Amphora necks stood out on the tumulus, and dishes were strewn around. I had time only to grasp three stacked wine cups and a corroded bronze boat hook in my urgent climb to the surface.

Professor Benoit in the launch saw a hand come out of the water holding three terra-cotta wine cups. He grew red in the face and shouted, "They're Campanian!" He had found the same type of cup in earth diggings in the Greek *oppida*, or strongholds, of Pro-

vence, of the 4th to the 2d century B. C.

Aboard *Calypso* that night, Marcel Ichac, the Himalayan mountain climber, lifted my three nested cups from the mess table. The cups were stuck together with mud, but Ichac had noted that they were stacked with the twin handles at right angles to each other. With a ceremonious solemnity which impressed us all, he carefully separated the wine cups and said, "I am at last taking apart, after 22 centuries, things that an expert hand has arranged."

His remark struck us all with the recognition that we weren't diving for museum pieces. These things had been made and stacked by living people, the last a professional packer, whose deftness carried from his hand to ours over the centuries.

All this was to grow more fascinating when we got to the proper study of sailors like ourselves. What was this ship, and what kind of men sailed her? A slowly unfolding series of clues and sudden revelations came out of the mud under Grand Congloué.

There was no further question about the Maire Island wreck. At Grand Congloué we had come upon the oldest seagoing cargo ship ever found, according to Professor Benoit and our field archeologists, Ferdinand Lallemant and Henri Médan.

The following days of that August were almost hysterical. We had 15 topnotch divers going down to the wreck like porpoises and sending up loaded baskets. We continued without thought of the early mistral that blew upon us late in the month.

Divers Undaunted by Mistral Storms

The Mediterranean mistral is a storm of late autumn and winter, which descends dry and fierce from the Rhône Valley and fans out to sea between Marseille and Toulon. In 1952 it came two months early. In smoking white water *Calypso* heaved and strained at her leash to the island, while the happy divers plunged into the surf. We winched out basket-loads of jars and pottery in seas that broke over the stern.

The gales could not stay our eager collecting, but the facts of undersea life soon did. We had skimmed hundreds of cargo jars and every piece of dishware from the mound and were digging with our hands to penetrate the next layer. But these objects seemed imbedded in cement. When we fought the handles of an amphora to free it, we would break it in two. Early in September we put



★ Argosy Sank 10 Miles from Port

Research as fascinating as a detective story indicates Sestius, a Roman trader, as the probable owner. The ship is believed to have left Delos around 230 B.C. for the Hellenic colony in Massalia (modern Marseille). Overloaded, she foundered off Grand Congloué. The National Geographic Society-Calypso Marine Archaeological Expedition began salvage operations (below) in 1952.

★ The Wreck at Rest

The Grand Congloué relic is thought to have had a big mast and bulkrate sail. Sinking upright, she lodged in a cradle of rocks, and her anchor fell on a shelf. Blanketed in mud, the ship slept virtually intact until Calypso's divers awakened her.

Filter basket and tailings of suction pipe

Engine house

Derrick

Diving ladder

Suction pipe

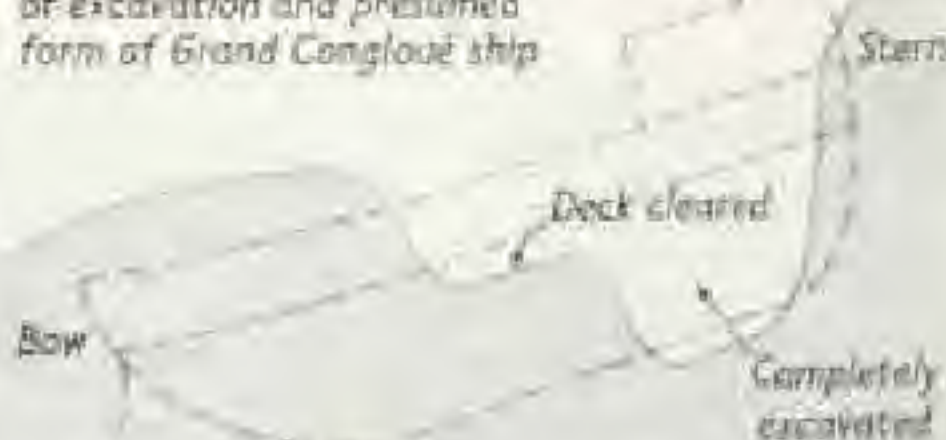
Calypso

Overhang

Anchor of wood and lead lodged here as ship sank. Only leaden stock survives.

Shelf 65 feet below surface

Longitudinal cross section of excavation and presumed form of Grand Congloué ship



Cross section

Original outline
Pottery squeezed from hold by collapsing deck



Deck cleared, knees and ribs exposed

112 feet deep

Salvage basket

Stern excavated

Partly excavated bow sections

140 feet deep

Gunwales

Drawn by Irene E. Adelman

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12

Illustration by Jacques Kéroul

♣ Divers Ashore Examine Salvaged Dishes. The Ship Carried an Estimated 15,000 Pieces

Potters in Italy mass-produced the wares found in the wreck's upper cargo levels. "The deeper we search," Cousteau reports, "the finer the quality. Each yard is a lead off the artichoke of history."

✦ Ferdinand Lallemant records items in his archaeological diary. Left to right: Stacked plates, a fragment from the hull, two amphora corks of volcanic mortar, two drinking cups, a perfume flask, bowls for candy, a water jug, a fish plate atop a broken jar, two shallow wine cups, and some sea-worn platters. The shiny dark Campanian dish was brightened with shoe polish as Dumas's hoax on Lallemant (page 16).



down a suction pump to work away the mud and free the cargo.

Without going into the long struggle Dumas and I have had with the theory and performance of undersea suction pumps, debating whether they would simply flatten their nozzles or gallop away with the operator like a Loch Ness monster, I shall simply record that this pump worked. We carved amphorae out of the mother material with it, like inspired sculptors for whom the clay shapes itself into classic forms. We were all Phidiases with the nozzle of the pipe.

Sometimes we got astride it and felt it vibrate like a spirited horse's neck as we turned on the compressed air (page 5). And, like a browsing horse, the mouth went forward into the pasture, munching shells, sand, shards, and things too big for it to eat, such as heavy hunks of wine jars. When an amphora neck jammed in the pipe mouth, another diver with a hammer pulverized the obstacle.

When the pipe was truly clogged, the expert operator turned off the sucking air. The mouth for a moment took in a reduced flow of pebbles, sand, and pieces of dishes racing each other to go to the surface. Then the pipe coughed rather apologetically, belched, and spat its impedimenta back on the floor of the sea.

Above water the pipe ran along the crane and under the engine house to a filter basket around the eastern cape, so that the mud tailings would not pour back into the sea and blind the workmen in the wreck. In the filter, aflash with white water at 12 gallons a minute, our resident archeologists watched for small treasures.

Prizes from a Mud-devouring Monster

The pipe fetched up many objects that the divers might have missed. One day Lallemant saw something swirling into the filter basket and leaped into the spray. He emerged with a black-varnished Campanian wine cup. It had survived the wreck, the erosion of centuries, the terrible pipe, and the crash into the filter—our first varnished cup from the wreck.

The divers did not want to pulverize objects (everybody on the *Calypso* soon became a lay archeologist), but they had to hurry; at 140 feet a man can dig effectively for only 17 minutes without having to undergo stage decompression. A touch of depth drunkenness, moreover, comes upon him at the end of his third dive of the day. What with the thrill

of the pipe and a bit of narcosis (diver's blackout), some delicate cups may have been atomized across the nozzle. However, there are at least 15,000 pieces of Campanian pottery in the wreck, by an early estimate.

Once I myself was a vandal. At the Anthéor galley, which we excavated briefly in 1948, we found amphorae containing wine. At Grand Congloué we waited through each layer for a jar still sealed. It came early in the digging, a jar with an outer *petruolam* (volcanic mortar) seal and inner cork hermetically set in resinous pitch.

We had found about 20 such sealed amphorae, but the others had had a hole drilled in the neck, as if the old crew had breached the wine cargo. (Perhaps that is why they sank!)

A Taste of 2,200-year-old Wine

Uncocking the jar, we took out about a quart of wine dregs in a specimen bottle. We thought we had discovered the "wine layer" of the wreck and started joking about how hard it would be for *Calypso* to stay sober with thousands of gallons of wine coming aboard.

Then Lallemant and I, as professional and lay leaders of the expedition, poured glasses of wine and downed them. He managed to spit his out on deck, but I swallowed mine.

I tasted all the mustiness and age there is in this world. The Greek wine had been de-alcoholized, but it had no taste of salt. A poor vintage century, that wine.

We have not found a second amphora with wine dregs in all the months since, after thousands of dives. There may not be another. We should have delivered the amphora, without breaking the seal and in an airtight bag, to a laboratory where the 2,200-year-old wine could have been professionally analyzed.

Sea and air are different biological environments, as we learned from the staff of the Endoume Marine Laboratory (the Marion Laboratory of Marseille). Early in the stormy days there came aboard Prof. Jean-Marie Pères, head of the station, with Jean J. Blanc, sedimental geologist, and J. Picard and R. Molinier, biologists. They were joined by J. Brouardel, assistant to Prof. Louis Fage, director of the Oceanographic Institute, in Paris, and a specialist in marine algae from the Sorbonne, R. Magne.

One of the microbiologists asked me to go down and wrap a fresh-dug amphora in a rubber meteorological balloon, so that he could

Cousteau Fastens the Bolts → on a Watertight TV Camera

↕ Flanked by flood lamps, the air-balloon camera hangs beneath *Calypto's* diving platform before descending to the wreck. Protected by a specially designed casing of steel, this Thomson-Houston camera can go down 400 feet. The French are experimenting with new types designed to sink 16,500 feet.

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↕ A Diver Collects Bowls and Lobster

While rising with some delicate Campanian ware, Henri Goiran pauses to catch his lunch from a crevice in the coral-fringed wall.

Even in summer Mediterranean waters are warm only in the top layer. A second layer some 50 feet deep is of moderate temperature. The zone beneath drops abruptly to 55° F. In winter the cold mistral out of the Rhône Valley blows away the warmer surface water. Then *Calypto's* divers must brave a longer, chillier *entrister* down to the Grecian wreck.

Here sunlight exists only as a diffused, gray radiance.

Reproduction by Jacques Cousteau and
Left: Jacques-Yves Cousteau

14





"Lower the Camera!" Cousteau Signals

Working at 140 feet is an exhausting job. Since divers are permitted only two or three 17-minute shifts a day, their time is precious.

If an Aqualunger must return to shipboard to consult an archaeologist about every salvage problem, he cannot get much work done, and even his most eloquent descriptions are too vague to satisfy the scientist. By focusing a television camera, however, the diver gives the archaeologist underwater eyes. Cousteau's Aqualungers soon grew adept at pantomime, acting out messages in front of the lens.

↓ This cameraman, lit by a flash bulb, maneuvers his bulky machine into position to telecast a marine disaster of 2,200 years ago. The screen of a small receiver enables him to focus his picture precisely.

Continued by
Jacques Cousteau (left)
and André Lotan



study its interior sedimental deposit while it was still uncontaminated by air. I complied. The scientific team has not yet published its findings, but it has found one new biological species on a Grand Congloué amphora and several new associations of submarine life.

In those amphorae in which the original stopper of pozzuolana, cork, and pitch had been lost in the play of ages, we found pieces of Campanian pottery, sea shells, and ballast pebbles. These remarkable intrusions might be explicable in a few tumbled or broken jars, but shards were also found in uncorked upright amphorae.

Amphora City Is "Octopied"

Who put the broken dishes in the amphorae? Who else but man's talented friend, the octopus? Almost every open amphora brought an octopus blinking out on the deck of *Calypso*. Marcus Sestius' ship was apparently the Levittown of the octopus, who had had thousands of homes dumped suddenly into his chronic housing shortage. The clever animal gathered pieces of dishes, pebbles, shells, and what not to erect a movable barricade at his door, and we were finding the pieces in the jars. The wreck has doubtless been "octopied" for two millenniums.

The suction pipe poured out significant small objects, notably the one real art object we have thus far recovered, a large fragment of a Megarian bowl with ornamentation in relief. The pipe, or "bazooka," as the divers call it, has also yielded beaten bronze hooks, copper nails, a bronze finger ring we call "the captain's diamond" (until a better name comes along), bronze knives, and fishermen's leads of all sorts for nets and lines.

Some of the sinkers are later than the wreck. Two have been identified as medieval. Centuries of fishermen have been losing sinkers at Grand Congloué.

After a month of work we took a friend to inspect the operation, Gen. Marie Eugène Aimé Molle, commanding the Southern Military District of France. The general was intrigued by undersea archeology and wanted to see the wreck for himself. He donned an Aqualung for the first time, coolly plunged 125 feet, and brought up a souvenir dish. The general is in his fifties. He caught a cold from the exertion, but his enthusiasm was unimpaired.

The persistent storms of September placed *Calypso* in great danger every time we moored to the rock (page 6). We had decided to

establish an engine platform on the cliff, from which the suction pipe and divers could operate, when General Molle interposed an offer to have the shore station built by Army engineers. As an invigorating military exercise, six soldiers and a young officer built the engine platform in three days, in waves that broke over their legs.

At this time we came upon the first dishes with patches of the original black varnish. On the top layer the Campanian ware had been rubbed bare and encrusted with white fossils. Lallemand began speculating on the possibility of retrieving buried dishes with the varnish intact. Dumas daubed an ancient bowl with black shoe polish and slipped it into Lallemand's collection. "Here it is!" cried Lallemand, lifting it reverently and transferring the polish to his hands (page 12).

Later the joke came true. Deeper in the wreck's holds we found thousands of black Campanian dishes in their original glossy state.

Argosy Plated with 20 Tons of Lead

At this writing, after a year, we estimate that there were 20 tons of lead in the Delian argosy. The entire hull and decks were lead plated. Even the copper nails with which the plates were fastened were covered with lead to prevent the corrosive action of one metal touching another in a salty medium. The Greeks knew nothing of electrolysis in theory, but as practical shipwrights they knew how to guard against its effects (page 35).

In November two cheerful, husky youths asked for jobs as divers. They were recently discharged Navy combat divers named Jean-Pierre Servanti and Raymond Kientzy, who had survived two years of fighting in Indochina. Both had deep-diving certificates and were excellent underwater operators. I said that, unhappily, the *Calypso* diving team was full.

"Well, captain," was the reply, "permit us to dive for our keep for a month or so, before we have to go ashore and find jobs."

I welcomed the offer. Our expanding commitments, now that we had both the ship and shore stations, had ruined our modest budget, and competent volunteers were a blessing. The lads quickly fell to work. Kientzy had a canoe that he cherished, so our crew promptly dubbed him "Canoe."

One day when *Calypso* arrived at the island, we found that a storm had moved the big cruiser buoy 500 yards out of position. Servanti volunteered to go down the buoy



Scientists Aboard *Calypso* View a Spider Crab on an Amphora 140 Feet Below

To demonstrate the efficacy of underwater television, Cousteau and André Laban designed a special housing for an industrial TV camera and had the divers train it on the wreck (pages 14 and 15). Two receivers showed pictures of 819 lines—nearly twice the resolution of American commercial telecasts. A loud-speaker device in the camera case enabled archaeologists to send orders down through the water (page 24).

chain to survey the situation. He surfaced and reported the chain had snapped off under water and the anchor was lost.

All day we hauled divers on long lines across the sea floor, looking for the anchor. No luck.

Then Servanti remarked: "When I found the broken chain, I noticed it left a furrow on the sea floor. Why don't I go down and follow the trail?"

Servanti's Last Dive

"It is deep water," I replied. "Take it easy. You probably can't find it in one dive." I gave him a small buoy to take down with him. "When you begin to feel tired, tie the buoy on a rock to mark the place where the next diver can follow on."

Servanti went down with the personal buoy, a small cork float on a light fishing line. After 10 minutes our watchers no longer saw bubbles on the surface—the diver's exhalations which tell us all is well.

Immediately the best diver aboard, Albert Falco, shouldered an Aqualung and went hurtling down. He found Servanti white and unconscious, arrested in the act of dropping

the buoy anchor on the sea floor 210 feet down. Falco, Ertaud, and Girault brought him up, and Servanti was placed in our emergency recompression chamber while the ship made top speed for Marseille. On the way we called by radiotelephone for the Marseille fire rescue truck, which carries a recompression chamber. We also phoned a medical specialist on diving accidents and had a hospital alerted to place the diver in a big recompression chamber.

We gave Servanti artificial respiration in the ship's chamber and continued it in the truck. In the hospital chamber he was worked on for five hours. But his life could not be saved. In his efforts to find the anchor he had suffered what we French call a "white syndrome."

In our grief over the loss of the gallant Servanti we considered dropping our excavation of the argosy. Then many of our friends came aboard, volunteering to take time off from their jobs to dive. The lost diver's best friend, Canoe, stuck to the ship. We decided to carry on the work that had cost Servanti's life. After two exhausting dives I recovered the anchor. And Canoe became one of our



best-liked and most effective divers, a regular member of the team.

Throughout December the storms went on. A blow one night swept the working platform into the sea, with all our big bottles of divers' filtered compressed air, the island's Aqualungs, and the winch. Toiling all night in the surf, our divers managed to save the 85-foot boom and the costly suction pipe, and in the succeeding days we recovered the lost articles from the bottom. But we thought it prudent this time to build a heavier engine platform, put a tin house on it, and run a ladder up the cliff to give access to the shell of the island.

There we erected the yellow tin house. It has beds for eight and a large dining-room-kitchen with electric refrigerator. The islanders have a radiotelephone to the mainland and a picturesque stone terrace decorated with amphorae they have recovered from the sea.

Although the place was named Port Calypso, the islanders sometimes call it "Radiant City," after architect Charles-Edouard Le Corbusier's controversial modern apartment house in Marseille. In this frigid settlement the men stayed all winter, diving every day in icy water.

Calypso's Guests Unload a Generator on Christmas Eve

By Christmas, Port Calypso needed a new and more powerful generator. We acquired one all right and swung it on board, but storms lashing the island would not permit us to send out launch in against the cliffs with such a load.

Docked in the Old Port of Marseille, we held a Christmas Eve party aboard *Calypso* for the crew and a dozen friends of our research activities. By midnight, champagne was bubbling like the exhalations of a diver. Then Armand Dayso, one of the islanders, peered out and said, "Why, look, no wind." The water was flat.

Before I could utter the suggestion, Yves Girault, a real estate man who dives with

★ *The Sea Eroded Some Plates; a Coat of Mud Saved Others*

Divers washing the sediment of centuries from still glossy Campanian ware brought up the best specimens by hand. Though fragile, one cup survived a rattling ascent through the debris-filled suction pipe. Seal on lowest plate was imprinted by mass producers who shaped identical plates by using wooden forms.

us, said, "Now I know why you invited us to the party. Cheap labor."

Everybody howled. The *Calypso* immediately put out for Grand Congloué, and in an hour the guests found themselves heaving away in the searchlight beam, transferring the heavy new generator to a fissure in the cliff face from which it could be winched up to the divers' hut. The next day there was a terrible gale.

Diving Starts the New Year Right

On New Year's Eve I offered to put all the islanders ashore, but they asked to have their wives or girl friends brought to Port Calypso instead. It was a fine party. Our star comedian, diver Armand Davso, was bawling out a street lullaby when Pierre Labat suggested that we should bring up the first amphora of 1953. In a moment Aqualungs were commandeered. At midnight a diving party pelted down through the cold water and picked out a nice amphora as the symbol of what we were going to do in the New Year.

As the ancient ship led us on to larger and longer effort, it became a struggle to keep apace with the necessary money. From the beginning, our project had been supported by the Ministry of National Education and the French Navy. Then M. Coutaud, director of Marseille harbor, came forward with aid in services and supplies. M. François Juniet, head of the lighthouse administration, lent his doughty tender, *Léonor Freynet*, to lay our heavy mooring buoys, lift rocks from the wreck, and run supply missions to the island. General Molle got the Army into the act by lending his engineers. The City Council subscribed funds, and so did the Prefect of the Department of Bouches-du-Rhône, who lent unexpected financial support at a tough time.

Next we were adopted by the Marseille Chamber of Commerce. This unique organization, founded in 1399, is the dynamo of the city. It is not a mere trade association. The Chamber of Commerce built and operates the great docks of Marseille, runs the Stock Exchange, and drove the celebrated 4-mile Rove canal tunnel from the sea to the inland waterways. Everyone in Marseille, it seemed, wanted to help the bedraggled *Calypso* and the stout lads of Port Calypso. Salvaging the ancient ship became a civic cause, like the building of a cathedral in the Middle Ages.

And the National Geographic Society, which had helped us so much with our earlier projects

in the Mediterranean and the Red Sea, came forward in 1952 and again in 1953 with generous American support (page 21).

Early in May we planned a special photographic and amateur film sequence on the island, in which the divers would dress in Greek robes and feast from our Campanian plates. It began as the sort of stunt that modern journalism demands; but it soon became something else entirely—an explosion of springtime among the men.

They had toiled the cruel winter long, and now the shades had lifted from the harsh northern side of Grand Congloué, and the sun gleamed on the white rocks and yellowish maquis. Perhaps there are more spectacular spring flowers in the world, but the two or three little blossoms that grow on our island became festive bouquets. Birds were nesting, and lizards sunned themselves on the warm rock.

The Greek banquet in the open air became a communion with the past, hilarious with wine and high feelings, but with a meaning that none could escape. The Campanian dishes had arrived at the customer's table. We had the sense of handling real things and not museum pieces.

One small type of bowl, whose function could not be determined by the archeologists, the divers spontaneously filled with olives. It was the perfect olive dish. We believe it was so employed by the Greeks. Fruits and meats were beautiful on the black plates, and mustard spread in a small dish became nectar. We understood the refinement of Greek taste; black dishes brought out the beauty of food.

Lips and Pebbles Provide Puzzles

On the 15th of May, 1955, we reached the keel of the argosy. It is a complicated structure of oak, 50 centimeters wide and 75 centimeters high (about 20 and 30 inches), indicating a ship larger than we had previously dreamed.

The digging gradually disclosed the story of the ship. We determined its itinerary from Delos, via the Gulf of Gaeta, by the order of cargo stowage and the styles of amphorae.

But each clue brought new puzzles for the archeologists. In the same ship were found two types of amphorae, which they had previously attributed to different ages. The theory by which they worked had it that the angle of the lip of amphorae, whether straight or slanted, was a method of assigning jars to

different periods. Yet in the galley we found jars with every sort of lip.

In addition, the suction pipe brought up quantities of polished black volcanic pebbles the size of peas. This rock is unknown in the Marseille area. It must have come in the ship. Was it ballast stone? Or might it have been imported mosaic tiles spalled in the hold during a previous voyage?

When Lallemant mentioned the possibility of finding coins, the divers fed modern aluminum 5-franc pieces into the suction pipe to give him a deceptive thrill. Once they sent up a small octopus that arrived alive and indignant at Lallemant's feet. Another way of tormenting an archeologist was to pretend to stub a cigarette in one of the old dishes.

In the spring our divers found sections of lead pipe about three inches in diameter and with holes drilled for joints. It was a find of the first magnitude. The stern section was yielding yards and yards of lead pipe. What was it for?

We have not jumped to a conclusion. Perhaps the pipe was part of the captain's personal plumbing, since the ancient skipper most certainly was quartered in a deckhouse at the stern. But if we find pipe in the bow section, the weight of evidence will lean toward a pumping system. It is not to be credited that the crew was supplied with privies.

We had good evidence that the western end of the mound, where we were digging, was the stern of the argosy. In that area we found smoke-blackened marble dishes, obviously cooking utensils for the crew. The sailors built their cooking fires on a hearth on the poop deck, so the smoke would drift into the wake.

Ship's Anchor Found

One day the ship's surgeon, Dr. Jean-Loup Nivellean de la Brunière, had finished a trick of work on the wreck and was ascending along the cliff wall to admire the red gorgonians. Sixty-five feet from the surface he arrived at the shelf which runs along under the engine house and crane. There in a small fissure lay the leaden anchor stock of the ship, as it had caught when the hull went down (page 11). Its location was above the eastern end of the ship mound, clearly establishing that as the bow of the craft.

He did not touch the anchor. It has been left as it lay. At the end of the work we will make a careful excavation of the shelf around the anchor to see what it will tell.

The wooden parts of the anchor, of course, are gone. But archeologists in Italy and France have reconstructed a valid picture of ancient anchor design. The post and hooks were of hard wood. The crossbar, or stock, at the top was made of lead, and the hooks were joined to the post by a lighter collar brace of lead (page 28).

Unlike the modern anchor, this ancient one had the heaviest weight at the top. This was necessitated by the fact that the ancients did not have chain cable, but used rope on anchors. Rope might easily stretch taut in a wind and pull the anchor loose if it did not have a heavy weight at the top. Modern chain cable always hangs in a loop, even under heavy stress, so that the pull on an anchor is horizontal. Top weight is therefore unnecessary.

Ancient Wood Shrinks in Air

We have been impressed by the variety of woods intelligently used in the old ship and by the skill of the joiners. Planking, sheathing, keel and main timbers, knees, ribs, and dowels are a combination of Aleppo pine, Lebanon cedar, and oak, and we have found several other woods which are under analysis. When uncovered on the bottom, the wood appears to be sound, but when handled it feels rubbery. It is rotten and tunneled by shipworms.

In the air the timbers dry out, and the intricate mortises flake away. A section of massive rib shrinks to a third of its size.

We are now unloading amphorae and other pottery without disturbing the deck. At the end of our work we intend to have a barge standing by on the surface with "embalming" fluid in big tanks. We will then attempt to raise large areas of wood and quickly saturate them in preservative.

We have also found a variety of metals shrewdly applied to differing tasks. In addition to the staggering amount of lead, there are iron fittings and tools, and bronze nails, some 13 inches long (page 35). Thousands of small copper nails, coated with lead, have arrived in the suction pipe. They were used to fasten the lead plating to the ship.

No precious metals have been found. There may be a bronze figurehead buried in the bow mound, under a 15-ton boulder which we shall have to remove to excavate this area.

We have brought up one large, strange, beaten-lead sculpture, heavily encrusted, which seems to have been a bull's head shaped over a wooden carving. The wood has vanished,

and the metallic part is now being cleaned.

After enough Campanian ware was available for analysis (we had uncovered by far the largest lode of such dishes ever found), the archeologists made an interesting discovery. There were more than 40 types of dishes, bowls, and pots, and each was standardized.

Greeks Mass-produced Wreck's Dishes

The dishes have slight circular indentations which could not have been made by a potter's hand (page 18). Comparison revealed the same rings on each specimen. This shows that the potters had turned out dishes shaped by wooden forms, a remarkable evidence of mass-production techniques two centuries before Christ.

The ware was probably packed in wooden cases. These have deteriorated completely, but have left the dishes stacked in discernible groupings. The hand of a skilled export packer is evident. The handles of cups are stacked alternately at right angles, and some large dishes serve as nests for smaller ones.

Black dinnerware has been found in dry earth from Britain to the Black Sea. It was one of the main wide-flung exports of Hellenistic times, an important civilizer which helped to bring table manners and an appreciation of gastronomy to less advanced peoples.

An Italian savant, who had recently completed a "definitive" book on Campanian pottery, the result of years of study of earth-buried specimens, visited us at the island. When he saw the black dishes coming up by the hundreds, he shook his head sadly and said, "My book is already out of date."

He had been studying dishes from the junk heap, as it were—shards buried in the



The Society's Flag Flung in Cousteau's Cabin

The author's undersea research has aroused widespread interest and support from scientific and industrial circles in several countries (page 19). American sponsorship has come from the National Geographic Society, which published Cousteau's first account of his work in English (page 11). The bronze nail he fingers was probably used to fasten heavy ship's timbers (page 35). Fragments of the hull's 20 tons of lead sheathing lie in the bowl.

garden, worn-out and broken bowls crunched under foot. At Port Calypso he gazed on piles of new dishes fresh from the production line.

This export pottery is not in itself of artistic value. Only stray pieces are hand-decorated. But its meaning to the excited archeologists is pleasant to see. They are building new concepts of ancient society from the ship.

In the spring we began to think about underwater television. We had experimented with TV in 1948, but the technique of that time and the equipment used were poor; so we had given it up, concluding it was not as useful as underwater motion-picture photography. At Grand Congloué, however, we



Scorpionfish Goes to the Chowder Pot

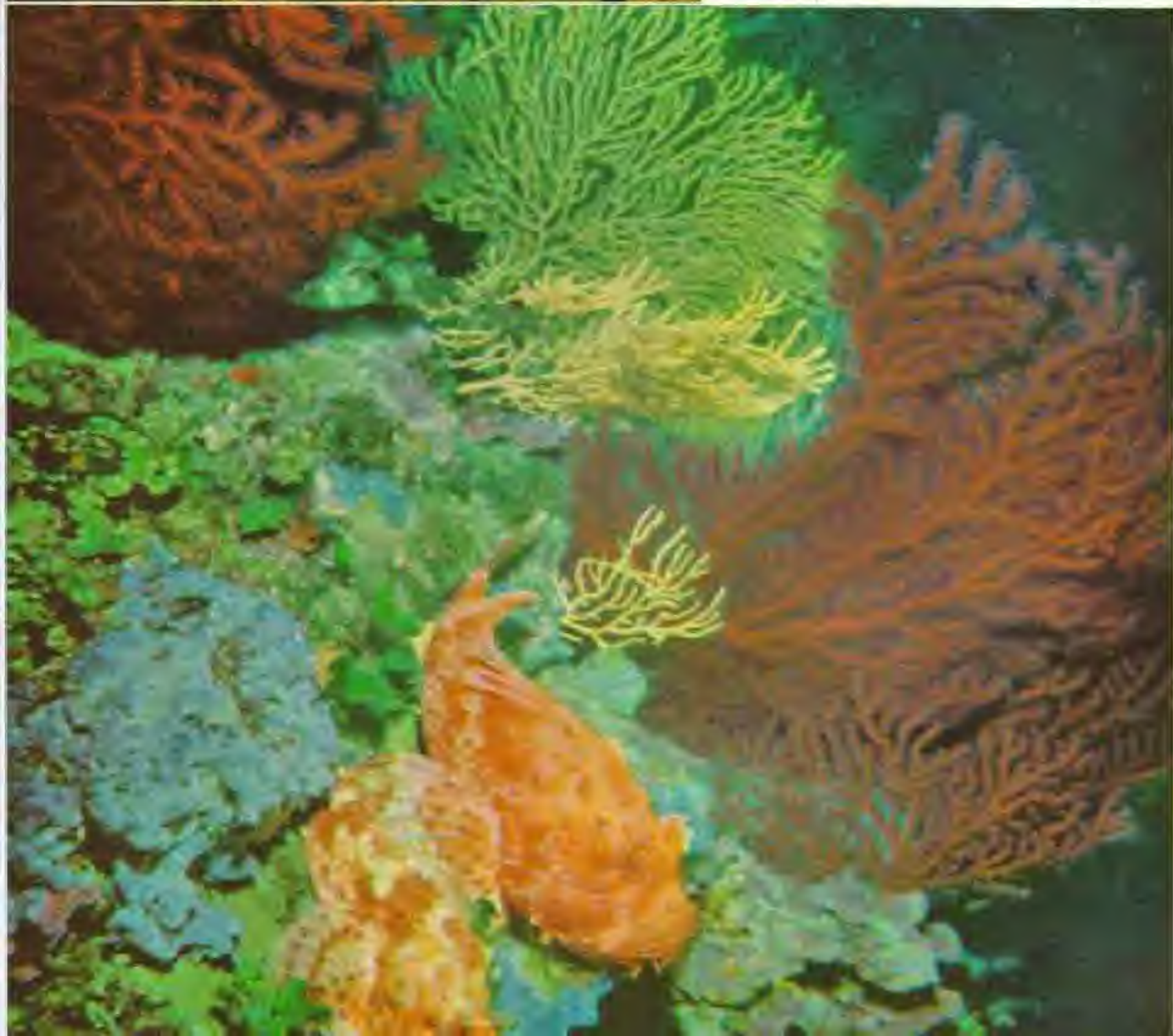
Marseille, *Calypso's* base, is noted among gourmets everywhere for its *bouillabaisse*, a fish chowder. Dropping a line over the side at every opportunity, the ship's cook fished for the dish's main ingredient, the *raie*, an ugly but tasty member of the Scorpaenidae family.

To the flesh of the scorpion and any other fish or crustacean that's handy, the Marseillais add onions, tomatoes, leeks, garlic, celery, and oil, together with a touch of laurel, fennel, and thyme. For further seasoning they apply salt, pepper, and saffron. "A noble dish," commented William Makepeace Thackeray in his *Sallad of Bouillabaisse*.

✦ Able to vary the mottled pattern of their skins at will, two scorpionfish camouflage themselves beneath a thicket of gorgonians below Grand Congour.

© National Geographic Society

Reproduction by Jacques Bérard (top) and Albert Jahn





✦ A Diver Dons His Suit to Face the Cold Abyss

Once he has wriggled into his full foam-rubber shirt, Raymond Kientz will put on his foot fins, and stocking-capped Albert Falco will help him into the harness of his Aqualung.

Until he goes over the side, Kientz will look and feel like a clumsy web-footed explorer from outer space. Once in his watery element, however, he will find that his tanks and tubes weigh only a pound or two and, freed from gravity's shackles, he will skim downward, roll over on his back, or float motionless in the current—a man fish.

Divers as experienced as Falco and Kientz have so accustomed their ears to pressure changes that they can plunge directly to 100 or 200 feet with negligible discomfort. An amateur, however, is likely to suffer sharp pains in his Eustachian tubes, especially in the first stages of a dive. At a depth of 33 feet the total pressure is twice the atmosphere's weight at the surface. At 100 feet, where *Calypto's* crew worked, the total pressure was 17 pounds per square inch, or about five times that of the atmosphere.

✦ Dumps, one of the world's most expert divers, scans the brilliant marine encrustations that have grown across the broken neck of a Greek amphora.



decided television might be a useful tool on at least one problem: that of the archeologists, who were directing the most important dig of their lives and couldn't see the excavation.

Television Mirrors the Sea Floor

The British Thomson-Houston Company generously offered to cooperate by lending a television camera, cables, monitors, and expert technicians. The Marseille Chamber of Commerce joined in the venture, together with our new French Office of Undersea Research. Dr. Pierre Dratz, of the National Center for Scientific Research, built a unique wide-angle lens corrected for underwater use, and the watertight caisson (page 14) was built by André Laban, able young engineer of the new research office, and myself.

I should make clear that we were not trying to broadcast pictures but to experiment with placing an industrial TV camera in an inaccessible or dangerous place to transmit pictures by cable to a monitor, where technicians could watch the process. We located receivers in my quarters on the *Calypto* (page 17) and in the divers' ready room, so that 20 viewers might be accommodated.

We employed the French TV system, in which there are 810 lines on the receiver, almost twice the number used in U. S. commercial television. Cables leading from the ship to the camera were buoyed at regular intervals to remove their weight, and we designed the camera housing to carry just enough air to render the unit weightless under water. In the air it weighed 200 pounds.

Yves Girault, a splendid diver and general secretary of the French Office of Undersea Research, handled the camera on the first test, a submersion of 65 feet, using natural light. We saw myriads of little jellyfish and a sad, monotonous bottom—a rather ordinary undersea view but exciting to us. Our television worked.

World's Brightest Underwater Bulbs

The next test was made within the wreck at Grand Congloué, and was witnessed by a party of Marseille notables and engineers from the various outfits that had worked on the project. Jean Delmas, our diving equipment chief, was the cameraman, and we had two additional devices on the camera.

One of these was a pair of reflectors holding the most powerful diver's electric-light bulbs available, 6,000-watt overvolted Mazdas (page 15). Turned on in the air, they

would melt and explode in 30 seconds. They can be used only under water, which is the best cooling system. The bulbs cost \$90 each and are good for one hour.

Our second gadget was unveiled after the lights had glimmered down into the blue and the audience was watching beautiful gorgonian fans passing by the cameraman on his descent. Chignard, electronics engineer of the Chamber of Commerce, took a hand mike and said, "Delmas! Delmas, what are you doing? Correct your focus."

A hundred feet down, Delmas heard this as the voice of Poseidon, for there was a loudspeaker in the camera cage. The watchers on the ship saw the images grow sharper. Delmas had adjusted his focus. He proceeded to show us Canoe digging with the suction pipe.

The audience took turns saying hello to Canoe, who waved at us from the pit in the ship mound 140 feet down. He could not, of course, answer us, but when we asked him, "Show us that nice dish there at your left knee," he would hold it up. It is impossible to smile while gripping the breathing tube in your teeth, but we had the impression of Canoe's ample grin. Delmas then showed us the anchor of the argosy in the recess where it was snagged as the ship sank 22 centuries ago.

TV Gives Archeologists Undersea Eyes

At first the divers were uncomfortable at being televised; then they accepted it as a reassuring presence, through which they were watched by friends. It gave them a feeling of safety.

For the archeologists, the new window on the sea was a revelation. They found themselves employing the newest electronic science in one of man's old studies. Staid specialists, they could sit in warmth and dry comfort and watch an underwater workshop. Their minds were clear. They could consult each other and direct the work by telephone.

We had had several misunderstandings between the specialists and the divers before television. When, for instance, the divers had spoken of the lead plating on the underside of the main deck, the experts said that was a mistake—the plating could only be on the upper surface. The divers got angry. Afterwards they enjoyed turning the TV camera on exhibits of lead plating under the deck.



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25

Photographs by Jacques Etienne

✦ *Calypso's* Gourmets Like Their Mediterranean "Violetes" Raw

Diver Kientzy (left), a former frogman with the French Navy, samples an ascidian in company with Yves Girault, general secretary of the French Office of Undersea Research. Nicknamed violetes by the Marseillais, these sea animals taste strongly of iodine.

✦ Cousteau's Dachshund Appears Built to Inspect Suction Pipes

Scaphandrier, whose French name means "flag-son diver," deigned to take an occasional swim, but preferred to pace the quarter-deck with the captain and supervise the cook's activities in the galley. Scaph never tired of looking into the hose for rabbits.





An Antique Cargo Arrives in Marseille 22 Centuries after Shipment

By the 3d century B. C. Greek argosies consistently spanned the Mediterranean. The one discovered, carrying wine and pottery from Dolos to the ancient Massilia, touched down just short of her goal. Salvaged from the sea, a few of her thousands of wine jars are here unloaded on the Quai des Belges. When bystanders blocked traffic and pilfered several jars, Captain Coustau started making deliveries at dawn.

Diver Goiran had a running joke with Lallemant. He told the archeologist that the divers were tired of digging up valuable things and having them taken away to the museum. The boys pretended they were putting the best stuff in an underwater grotto and were going to sell it later for fancy prices. Asked Goiran: "Lallemant, how many dollars will you pay for a big Grecian vase with beautiful pictures on it?"

After Goiran had gone down, Lallemant lowered a dollar bill in a bottle.

Goiran's next move was secretly prepared and sprung while the Marseille dignitaries

were watching the test. Suddenly the camera discovered a display of fine Campanian dishes on the bottom. Each was placarded with a large price tag, and Goiran was pantomiming an auctioneer, appealing to Lallemant on the ship to bid high. The archeologist grabbed the mike and refused the offer. Thereupon the diver produced a large hammer and pretended to smash the dishes.

Jacques Ertaud, our cinematographer, took the camera down without knowing that a loud-speaker had been installed. When he first heard the hollow ghostly voice, he abandoned the camera, thinking he was overcome



by depth drunkenness. He went up rapidly to relieve the pressure, then stopped and sheepishly went back to the camera.

Canoe, Henri Goiran, and André Laban took the camera and lights down for a night (television test). In the bright light we saw hosts of little bogues and castagnolles (*sea bream*), "the flies of the sea." A big scorpionfish hovered near the divers and would not move. He got his ugly face on television. They turned the light off, and in the dark the scanning tube picked up phosphorescent *noctiluca* glowing like stars.

Television, we found, has much greater light sensitivity than do motion picture cameras. We could obtain scenes in natural light well into the deep blue. The artificial lights were helpful only to give better contrast to the images.

At the back of the camera case we made a porthole through which we could view the screen of a tiny receiver. The divers watched its little picture with fascination; often the image was clearer than the object they saw with their eyes. Guided by it, they could adjust the focus and frame the scene.

Tridents Point to Argosy's Owner

In a sketch of the original voyage at the beginning of this report, I have named the man who owned the galley and the probable time of its sinking, an attribution which will probably raise the neck hairs on even an amateur of archeology. I am an amateur myself. The startling facts, however, come from the professionals like Benoît.

How did they find out such an incredible thing as the name of the shipowner after nearly 2,200 years? There were no human remains in the wreck and no documents. There were no stone epigraphs to recount the tale. Benoît's discovery is a first-rate detective story in itself.

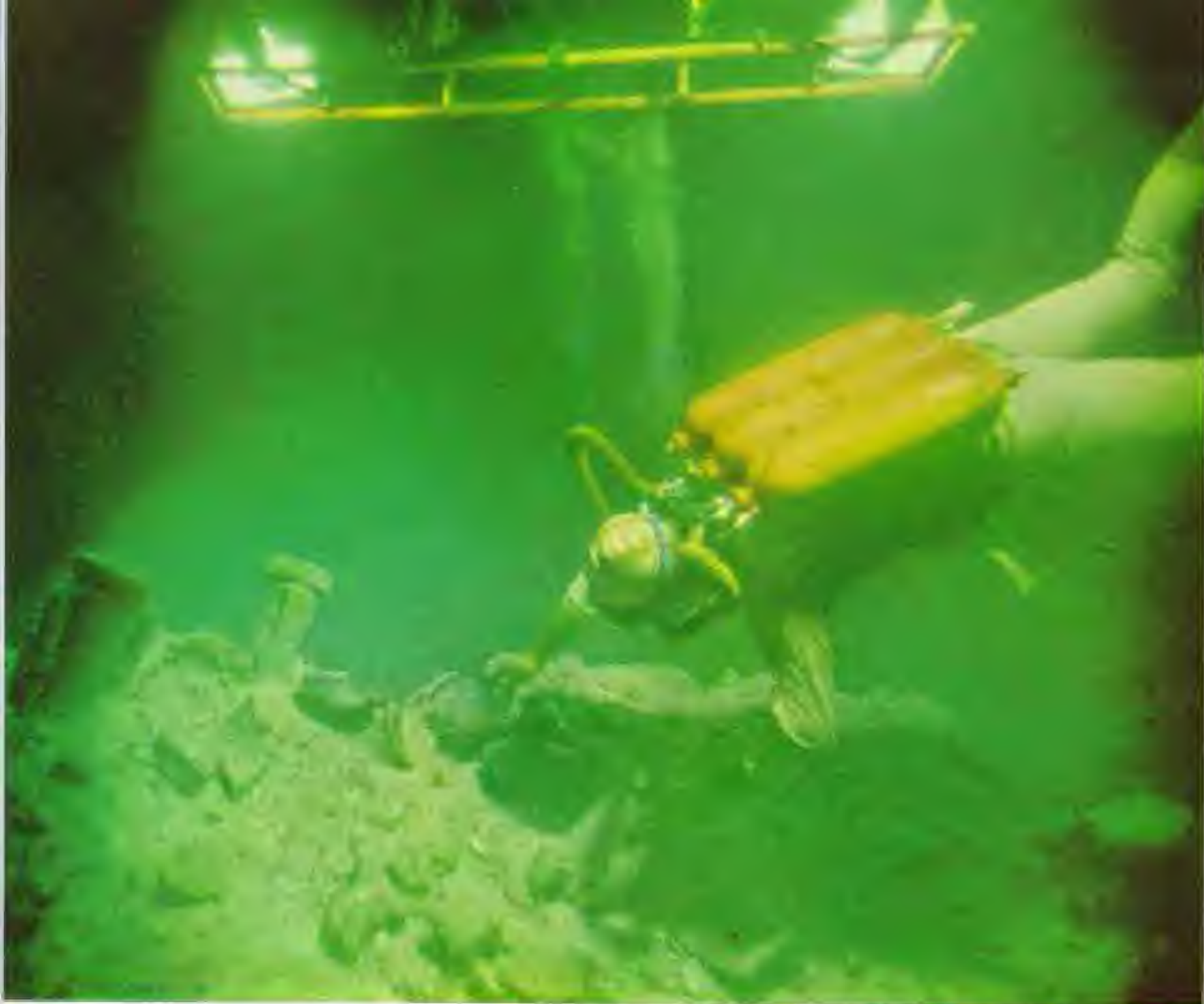
When we dug into the first layer of amphorae, which had not been too heavily covered with fossils, we obtained jars with two stamps impressed in the lip. The first mark was "SES" in Roman letters, followed by an anchor symbol. The second variation was the same initials with a trident symbol (pages 32 and 33).

What did "SES" mean? It was quite probably an abbreviation of the shipowner's name, since the Romans were great abbreviators. By ransacking classical genealogy Benoît found a prominent and powerful Roman clan named Sestius. The amphorae and dishes had already assigned the ship to the 3d or 2d century B. C. The professor went to Italy and searched the genealogies and annals and came up with numerous references to a 3d-century Marcus Sestius, a noted merchant shipowner.

Sestius a Roman Fifth Columnist

In the annals of Titus Livy, the Roman historian, Sestius is prominent enough to have received several references. One is to the fact that he went from Rome and set up in the shipping business in the Greek isle of Delos. According to Livy, he was what is now called a "fifth columnist," a commercial adventurer who settled in the alien island to hasten its downfall to Rome. Even before Rome conquered Carthage, she was expanding her empire overseas and making her power felt in both ends of the Mediterranean.

Livy mentions that Sestius built a fine



† A Floodlighted Diver Scoops Up Dark Campanian Dishes

One Campanian-pottery expert who had just completed a lifetime's analysis of fragments grubbed from the Italian soil took a look at Calypso's wealth of unbroken ware and exclaimed in despair: "My book is already out of date!"

Bulbs lighting this scene are the undersea world's brightest: 5,000 watts. In air they would explode in a few seconds. Cooled by the sea, they last an hour. Cost is \$90 apiece.

→ The diver's hands span a major troughy, the leaden crossbar of an anchor. Since ancient ships used woven ropes rather than weighty chain, they needed a heavy stock to hold down the anchor's wooden flukes and make them dig into the bottom.

© National Geographic Society

Illustrations by Yves Miquit (top) and Albert Fales





★ Wide-eyed Diver Brings Up a Prize Jar

Before the TV camera descended into the depths to oversee activities, Cousteau's divers used to tease the archeologists on ship-board with hints of a cave in which they were hiding all the truly rare and precious recoveries. Actually, as the divers learned more about the ship's antiquities, they grew as excited as the scientists and brought their best finds up with eager pride.

This man holds an amphora resembling neither the Greek nor the Italian jars lining the argo's decks. Archeologists decided it must have been a product of the island of Rhodes.

© Underwater by Albert Falot





Ship's Timbers, Exposed to Air, Shrank Quickly

When divers found the sunken argosy's main deck surprisingly firm, hope grew that the entire ship might be raised intact.

Fragments brought to the surface, however, shriveled and crumbled. Some, such as this dark curved timber, were embalmed in a preservative.

✦ These wooden bits are being analyzed and preserved for the building of a model argosy.

Bronze fish hooks in the man's palm are thought to have belonged to the ship's sailors.

Harold D. Kilgus

30



peristyle villa in the Roman traders' quarter of Delos, the "heights" of the sacred city. Then, among the stone epigraphs of Delos, Benoît found an inscription setting forth that Marcus Sestius had received honorary citizenship (*isopoliteia*) in Delos in 240 B. C. This form of naturalization was often given to a distinguished foreigner by Greek cities; sometimes whole cities exchanged honorary citizenship for their populations.

Greek Sailors Kept Their Trade a Secret

With the date 240 B. C. to show that Sestius was already established on Delos, Benoît placed the sinking of the galley at some 10 years later. It may be incorrect by a few years.

Benoît's findings throw a beam of light on blank pages of early commercial history. Al-

though the Greeks wrote volubly on almost every subject under the sun, few descriptions have been found of their maritime commerce. Perhaps they did not think it important, but it is more likely that they maintained secrecy on their navigational arts to discourage competitors. Their rivals, the Phoenicians, carried secrecy to the point of deliberately running a ship on the rocks to wreck a competitor who was closely following them, trying to learn the Phoenician routes. The Phoenicians also invented terrible sea monsters, rocks, and whirlpools to scare off rival traders.

Pieces of amphorae carrying Marcus Sestius' trademark have been found in Burgundy and Alsace, showing that Marseille was a distribution point for Greek wine, which was carried up the Rhône Valley to remote and rude parts as early as the 3rd century B. C.

Wine was an advance guard of civilization; the geographical development of ancient society coincides exactly with the advance of the wine trade. After the amphorae came tableware, soldiers, artists, and priests.

The Greeks were a seagoing people, clever traders, and supreme civilizers. Greek colonists ranged west as far as Spain, and the Greeks had a thriving maritime commerce in all the Mediterranean lands. Yet all we know about their shipping is a guess and a few caricatures on vases and floor mosaics, which show impossible galleys and sailing vessels, as if their tremendous maritime achievement were a joke.

Because of these cartoons, some historians have a poor estimate of the capabilities of Greek ships and believe the vessels were rowed and were incapable of navigating out of sight of land. We know enough about the Grand Congloué ship, however, to demonstrate that it was far too big to be rowed.

Wreck Was a "10,000-Jar" Ship

At this stage of excavation our opinion is that the Grand Congloué wreck was at least a 10,000-amphora ship. It may prove to be bigger than that.

The amphora was the tonnage measurement of classical vessels. The Greek amphora was a standard container of about 6½ gallons for wine, water, oil, grain, olives, dates, resin, dyes, or ores—any liquid or granular product that would flow into and out of a jar. An amphora full of wine weighs nearly 100 pounds.

On the first anniversary of our work at Grand Congloué we were on our way in the *Calypso* to the isles of Greece to retrace the voyage of the ship, while a party of divers continued work at Port Calypso. We sailed southeast to the Strait of Messina and anchored under the rock of Scylla, dreaded by ancient navigators. Then we proceeded to the awesome whirlpool of Charybdis, where we stopped the ship and lowered the automatic electronic flash cameras of our friend Dr. Harold E. Edgerton, of the Massachusetts Institute of Technology.*

From the toe of Italy we crossed the Ionian Sea in one night, a passage that was a great prolonged test of ancient sailors, and began to thread our way through the Aegean Sea.

Delos, from which we think Marcus Sestius' argosy came, was believed by the Greeks to have been the birthplace of Apollo. The myth

recounts that Zeus found the tiny island floating in the sea and chained it to the bottom to be the birthplace of his son, Apollo. After that, no one was allowed to be born or to die on the Sacred Isle. Expectant mothers and dying people were transported to the near-by island of Rhenea (Rinia). A hymn to Apollo, which survives from Homeric times, described the isle where no one might enter or depart this world:

"But in Delos it is, O Apollo, that thou delightest above all others. For there the long-robed Ionians convene at thy feast, together with their gentle wives and their children, eager to please thee with their dancing and singing, their boxing and their appointed games.

"Should a stranger cast eyes upon them, much would he marvel at their freedom from age and from death, and with joy would he look upon their men and upon their women, girdled in beauty, and upon their swift ships also, and their abounding riches."

For perhaps a thousand years the Greeks, even the Egyptian Ptolemies, lavished on little Delos gifts of shrines, temples, and treasures to Apollo.

Immune at first from the endless wars, the sacred city was a free port, an asylum, a place of pilgrimage, and one of the richest cities in the ancient world. It had no taxes and merely a tithe on agricultural produce. In fact, the city regularly issued free wheat to the population.

Delos: Argosy's Probable Home Port

Above all, Delos was the most important transit port between the Levant and Greece, with traders of many nationalities living within their own enclave and following their own customs in the commercial part of the town. There was a synagogue at Delos and a Phoenician trading center.

Roman traders appeared in this tolerant place in the early 3d century B. C., advancing behind the spread of Roman coinage through the Greek world. The Romans were unpopular at first, but, under orders from the Senate, they married native girls, became naturalized, entered the cultural and religious life of Delos, and conformed to Greek law.

*For a vivid account and remarkable pictures of weird creatures from these depths, see "Fishing in the Whirlpool of Charybdis," by Paul A. Zuhl, NATIONAL GEOGRAPHIC MAGAZINE, November, 1955. See also "Burr Prizes Awarded to Dr. Edgerton and Dr. Van Biesbroeck," NATIONAL GEOGRAPHIC MAGAZINE, May, 1953.



† Ruins of Delos Yield Clues to the Ship's Owner

A fifth columnist for Rome's emerging empire, wealthy Marcus Sestius moved from Italy to the Greek Isle of Delos around 740 B. C. There he built a fine house and sent his cargo ships ranging over the Mediterranean.

Three bits of evidence point to Sestius as owner of the Grand Congloué wreck. Amphorae from its hold bear "SES" ciphers similar to those worked into the mosaic floor of this house. Black volcanic pebbles in the courtyard match those discovered in the wreck. The house itself reflects the sumptuous style ascribed to Sestius' mansion.

† Lallemand, Bob Edgerton, and Cous-
teau examine a trident whose lines seem
to form the E in Sestius' cipher.

By National Geographic Society

Illustrations by Jean Aronson (top)
and Harold W. Blanton

The Romans retained one joker: they could appeal from a Greek legal decision to Roman law. Such a merchant was Marcus Sestius.

The *Calypso* arrived at Delos on a gleaming summer morning and anchored in the strait. Neither the sacred harbor nor the commercial port of antiquity could be entered with our 8-foot draft. The harbors that once had taken fleets of argosies were silted to within a few feet of the surface.

Where the ancients had walked past marble columns in green groves, we saw yellow grass, thistle, and rubble. The sacred city is now a pin cushion of half columns and fallen stones on a lion-colored slope without oak or pine. In the golden sun under a cobalt sky there lay one of the finest cities man has made and destroyed. The ruins were waist-high.

Her harbors crammed with traders' vessels, and her slave trade booming, Delos flourished for many years; 10,000 slaves could be received and shipped out daily. Her decline began when the Near Eastern king, Mithridates the Great, stirred up hostilities against Rome. His fleet sacked Delos in 88 B. C., massacring 20,000 of the inhabitants, most of them Italians, and "liberating" the finest statuary. In 69 B. C. a pirate chief working for Mithridates sacked it again, but the mortal blow came when trade routes altered, leaving Delos almost abandoned.

In 1873 the French School of Athens began archeological work at Delos. There are now 35 residents, mostly employed by the museum or the tourist trade.

Jean Marcadé, chief of the French Delian diggings, aided our search for Marcus Sestius. He showed us the sorting rooms of the museum where thousands of inscribed portions of amphorae recovered from the earth are filed in drawers. None had the "SES" trademark. We found, however, a marble relief of a diver, which amused the *Calypso* divers. They thought the old fellow lacked technique.

Outside the museum, leaning against the wall, were a dozen Greek amphorae, shaped like ours, but not Marcus Sestius' property. We saw the sacred lake, now a walled patch of grass with a single palm tree in the center.

Marcadé led us to the Roman traders' quar-



Seal and Anchor Link the Argosy to Sestius

Scientists examining the Grand Congloué amphorae found seals bearing both the trident stamp (above) and the anchor motifs almost identical to those in Delos (lower and opposite).

ter on the lower slope of 367-foot Kynthos, Apollo's shrine. In narrow streets we looked across broken fieldstone walls at truncated columns in the courts of the great villas. They had deep cisterns, drains, and luxurious baths, some arranged as sitting baths. Several of the Roman merchants' houses had amputated marble statues and household fertility gods. We saw masterful mosaics in several courts.

Searching for Sestius in Fallen Delos

Past the ruins of the splendid theater we came to the richest street in the shipowners' quarter. We entered the peristyle court of a large villa, such a house as the home of Sestius may have been.

The court was paved in well-preserved ter-

Antiquities by the Cord: Coustean Stacks Jars in a Marseille Museum

These amphorae were shaped into heavy points at the bottom to give maximum strength against jolting impacts on stony floors. Where the ground was soft enough, they could be stuck into the earth. Handles made them easier for stevedores to move about.

Stowed aboard ship, the amphorae seem not to have been racked, but leaned lightly against one another.

Tall jars on left and center are Italian in type. They held about 5½ gallons of average wine, which the ancients mixed with water. The plumper Greek-type jars (right) held 6½ gallons.

✦ Cousteau checks cups from agency's cargo. Sailors had their own cruder mess water. No one will ever know if the crew went down with the ship. Unlike amphorae, most human bones seem not to last long in the sea.





✦ Bronze Nail Is 200 Times the Age of the Boy

To protect their ship's planking against wood-boring worms, the Greeks sheathed the hull with $\frac{1}{16}$ of an inch of lead and nailed it (not every 3 inches with smaller nails of copper. Aware of the corrosive action of one metal in contact with another, they coated copper nail heads with lead. The Grand Congloue army's leaden skin weighed 20 tons.

Rough bowl and cone in front of young Röriv Lallemand may have been counterweights for auxiliary masts or rudders. Ancient Greek ships were steered by two oarlike blades projecting from either side of the stern.



Divers in *Calypso's* Mess Swap Tales of Undersea Salvage

Cousteau's divers were spelled on week ends and holidays by volunteers fascinated by submarine archeology. Occasionally one fed an octopus into the suction pipe to startle scientists at the filter end, but all worked hard. Here Ertaud, Falco, Davis, Gouzon, and Girault relax over a bottle of raspberry cordial.

razzo tile. The central mosaic had a wave-pattern border, suggesting the sea. Another mosaic displayed an amphora-shaped vase in flower garlands.

We divers walked sadly around, looking down. Then we whistled. We crowded around a floor mosaic of a porpoise entwined with an anchor, such as the one on the "SES" amphorae. Someone discovered the second mosaic, an even more surprising one. It showed a befilaboned trident, almost the same trident as the Grand Congloué marks, but finer in detail.

James Dugan, a member of the group, squatted down with a yell of triumph. The trident exactly resembled a Roman E. Between the tines were two S-shaped brackets. By rearranging this possible cipher, we had "SES"! (Page 32.)

I happened to notice some black pebbles in the dust, which may have been mosaic stones. They were black volcanic pebbles of the same type as those picked up by our suction pipe in the Grand Congloué wreck.

These interesting coincidences and the fact that the house is in the sumptuous peristyle

design that Livy had attributed to Sestius' house brought us very near the conclusion that we were standing in the house of our shipowner. Marcadé remarked that it was a fine villa, but it had never been quite finished. We wondered whether Sestius had gone broke when his big ship disappeared somewhere west of Latium.

We do not ask anyone to believe that it was actually Sestius' house. Marcadé smiled at the suggestion and pointed out that there was no proof, despite the interesting clues. We live in a skeptical age of science. Some of us, however, will always secretly believe that this was in truth Sestius' villa.

3,500 Dives Thus Far

Our basic work, in any event, lies not in the sun-drenched ruins of Delos but in the chill, gray underworld off Grand Congloué. In one year our divers have logged 3,500 dives. Yet they may have to plunge at least as many times again before we shall have cleared the last amphora, the last dish, the last link with Sestius' world from his ill-fated ship.

To that task we turn in 1954.

Explorer-Vacationists Penetrate the Fantastic Narrows of Utah's Virgin River, Heart of Zion National Park's Many-hued Wonderland

By LEWIS F. CLARK

LET'S GO through the Narrows of the Virgin River this summer," wrote my brother Nate. He enclosed photographs which he had made on a brief scouting trip earlier in the year. His letter breathed enthusiasm.

We had long dreamed of such a trip into the wilds of southwestern Utah's Zion National Park.* Here the North Fork of the Virgin River has been chief actor in one of those geological dramas which were responsible for so many of our country's miracles-in-stone.

Nature's Wall Street 2,000 Feet Deep

Eons ago, when the land started to rise from the sea, a stream meandered gently southward. As the land rose, the stream cut slowly but inevitably into the underlying rocks. Like an endless belt of sandpaper, grit-bearing water scoured its way through layer after layer of sandstone until it dug a fantastic, sheer-walled canyon.

Today, with a fall 10 times that of the Colorado in Grand Canyon National Park, the Virgin River tumbles along a channel that reaches a depth of 2,000 feet; at the bottom it is little wider than many a city street.

We knew that the canyon of the Virgin River Narrows, like the colorful gorges of the Colorado River, is spectacular and awe-inspiring. How impressive it really is we were to learn by splashing along its gravelly bed and stopping repeatedly to look at the walls towering higher and higher above us. The chasms carved by the Virgin River are probably unrivaled for their dramatic combination of depth and narrowness (page 48).

Visitors to 148-square-mile Zion National Park, which cradles the Virgin River for part of its course, number in the hundreds of thousands each year, yet only a few are known to have penetrated all the way through the Narrows.

Perhaps the earliest was Grove Karl Gilbert, surveyor, map maker, and Trustee of the National Geographic Society from 1890 to 1905. In 1872 he traversed the North Fork from a point near its head to its junction with the East Fork. Mukuntuweap and Parunu-

weap, the Indians called these branches of the river.

The miles of canyon floor, in places only twenty feet wide between sheer walls sunk almost a half mile into the sandstone, he named the Narrows. He described the entire course of the North Fork as "the most wonderful défilé it has been my fortune to behold."

We believed a trip through the Narrows would take the better part of two long days. Summer would give more hours for travel and the best light for photography. Dry weather would simplify our camping gear.

Zion National Park has two dry periods, early summer and late fall. Between them comes a thunderstorm season, with occasional wild flash floods. We hoped that the first week in July would still be in the so-called dry period, and chose the long July 4th week end for our adventure.

Our equipment had to be lightweight, and waterproof in case we had to swim. Single-thickness wool blankets sewed into mummy-case bags, food for two days in the gorge, movie and still cameras and film, all were fitted into waterproof plastic bags.

In Zion, as in many other national parks, those who would go climbing or exploring beyond the trails are required to register at park headquarters. Rangers can then advise parties regarding safety precautions, and may dissuade leaders from unwise trips. They also know where to start looking if visitors fail to return as planned.

Rangers at First Said No

The first reaction of Zion's chief ranger was that we should not make the trip. From early July through August, he told us, travel in the Narrows is inadvisable because of the threat of flash floods. The thunderstorm season was imminent.

His views, admittedly reasonable, were an abrupt setback to us. Yet we were optimistic that the dry spell would continue. We talked for an hour and a half, going over the perils

*See "Utah, Carved by Winds and Waters," by Leo A. Borah, *NATIONAL GEOGRAPHIC MAGAZINE*, May, 1936.

of the journey and possible alternative trips.

Meanwhile, park officials realized that our leaders were experienced and that we had given much thought to the adequacy of our preparations and equipment.

Finally it was agreed that our party would drive to the plateau land near the head of the gorge and make a decision next morning on the basis of weather prospects on the spot.

Not far beyond the east gateway to the park we turned north off the Mount Carmel Highway onto a gravel road. Light clouds in the west produced a beautiful sunset, but made us wonder about the weather. "Red sky at night is the sailor's delight," goes the jingle. It was really orange, but we tried to see rosy hues.

Chamberlain's Ranch was supposed to be only 30 miles from the highway. Our county road bumped up and down for an interminable distance. We finally camped a few miles from the ranch. The night air was nippy, and we sat close to the campfire as we reviewed plans for the next day before turning in.

There is a time in the gray dawn when one can't tell whether the sky is clear or overcast. The stars had been bright earlier; now they were gone. I heard others stirring and decided it was time to start a breakfast fire. Soon we could see that there were no clouds—a good omen.

Uranium Prospector Had Been There

At the Chamberlain Ranch we talked with the owner and with a uranium prospector who drove by. He told of going down into the gorge several times. Their assurances strengthened our decision to try it.

We drove through a ford and followed a tortuous road. At its end a prospector's cabin stood on the edge of a flat that had been a meadow before the meandering stream had cut its banks and lowered the water table. We were then two miles east of the park boundary, and ready to start.

The three girls in the party were to drive one of our cars back to Zion Canyon—a trip with its own arduous aspects. They agreed to meet us about 4 o'clock the next afternoon at the south end of the Narrows in Zion Canyon; we nine men would try the river.

To their shouts of "Good Luck!" we strode off toward the stream. According to our map we had about 12 miles of water-grade route between us and our goal. This would take us through the gradually deepening upper gorge and between the towering walls of the Narrows to the Temple of Sinawava (map, page 51).

The broad, open valley contains a series of meadows and sandy flats through which the stream meanders. On either side pine-clad ridges lay under a sparkling sky. Soon the valley narrowed. There were occasional little cliffs as we splashed from one side of the creek to the other, sometimes wading midstream.

Heights increased as the creek bed dropped steadily. Through the woods we glimpsed a huge vermillion precipice. Awed, we gazed up to red sandstone, the source of the colorful stain streaks on the lower panels of the walls.

Periodically we counted heads. At one time half the party was missed; after a wait they came into sight around a bend. One man dangled a headless rattlesnake. The advance group had passed a sloping bank when Jannie Serna, always alert for living things, saw the coiled snake and caught it with a forked stick. In the noise of the rushing water the snake's rattling had not been audible.

From then on we were careful to watch beside our steps as well as ahead.

Detour via a Natural Stairway

By now the walls of the gorge were hundreds of feet high. Low waterfalls were easily passed or detoured at this stage. Then came one that was a problem. The narrow stream plunged past smooth rocks into a foaming pool of unknown depth. We hesitated to dive or jump. Then I remembered a remark of the park naturalist, and searched through the trees and thorny brush against the cliff on the left bank. There it was—a cleft barely two feet wide in a massive rock. Once through this, we descended a narrow natural staircase to the shallow end of the pool below the falls.

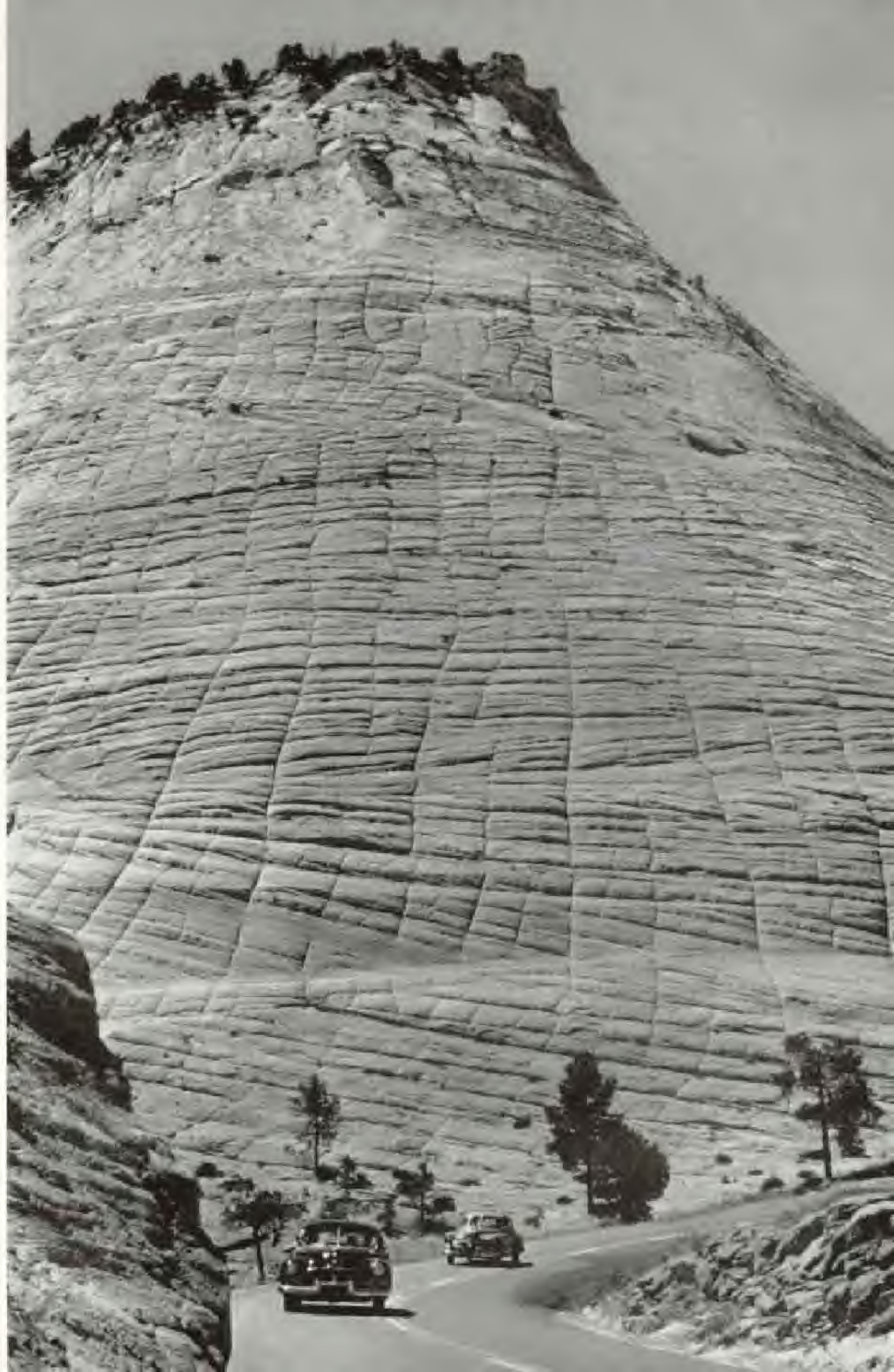
At an occasional break caused by an entering side stream, we tried to locate our position on the map. It was as baffling as a jigsaw puzzle. The main tributary streams were dry, and their narrow gorges were similar to the irregularities of the canyon walls (page 45).

The gorge became narrower. In places we felt as if the very walls were closing in on us. We watched for possible escape ledges where we could climb to a point beyond what appeared to be the high-water mark. We had heard rumors of gorge waters rising 100 feet in 10 minutes.

Crazy-quilt Patterns in Sandstone → Greet Visitors to Zion National Park

Checkerboard Mesa displays a geologic stratification found in several headlands along Zion-Mount Carmel Highway (page 55). Leaving the park, these cars approach the east gate.

Justin Lucien



Some say you can smell the misty down-draft ahead of a flood. There are reports of floods in other canyons in the park, and photographs of a wall of water plunging down like a wave crest. The thought that we could be trapped never quite left our minds.

In Dark Cliff passage the walls rose sheer and smooth, like the hull of a ship in dry dock. Cavern Passage was evidently cut through harder rock, overhanging and twisted. As we looked up, no sky was visible.

Abruptly the cavern opened out into a hall which looked deceptively simple. But along the shallow side of the stream we stepped into quicksand. Fortunately, by wading into deeper water we found firm bottom.

Farther on the walls parted again, and we passed into a natural temple. Sculptured cliffs with hues of buff, red, orange, and amethyst rose above us.

Through another portal on our right a clear and wider stream flowed along the far edge of the sandy floor. The bed was filled with round stones, many bluish gray. This was Deep Creek.

Just beyond the confluence the enlarged stream entered a narrow gorge and disappeared around a bend. As we looked up, the Y-shaped sky pattern of the cliff tops suggested a name, Upsilon Temple.

Several hours of sunshine remained on the open country above, but the light was already fading in the canyon. We selected a campsite on a rocky bar in Deep Creek, several hundred yards above its junction with the main stream. On an escape ledge we cached our cameras and extra food. Soon the pungent smoke from a driftwood fire gave promise of supper on the way.

Idyll in a Sandstone World

From a sandy couch I gazed straight up to three pine trees silhouetted against a deep-violet sky. The glow of the fire grew dimmer.

On my left, to the north, the stars disappeared behind thin clouds. Could it be raining in Cedar Breaks? I heard a roaring sound. The cool air was as fresh as ever. The sound grew louder, like distant thunder or a great waterfall.

Then I saw winking lights. It was a plane. Relaxed now, I watched the moonlight patiently revealing the upper walls of the chasm with a soft light. Then I dozed.

The next time my eyes opened the sky was paling. A fire blazed and the doubts of night were forgotten. Two ambitious lads accepted

challenges and took a dip in the cool dark pool, then galloped over for hot coffee. We resealed our sleeping bags in their plastic covers and tied extra clothing and film in waterproof bags.

Before the sun had touched the stream we were on our way again.

The canyon had looked forbidding in the evening shadow; now it beckoned with sunshine and a bright sky.

Although many of the intermittent tributaries enter the river in hanging valleys, from which their occasional waters leap as cascades and clear falls into the main canyon, Kolob Creek enters with quiet dignity at main-stream level. Beyond, at Amphitheater Temple, a beautiful green meadow was filled with grasses and wild flowers. Tall pines stood against the omnipresent cliffs.

Avalanche Tore Limbs from Pines

Downstream we had to climb over the debris of a fresh-looking avalanche. Tons of rock of all sizes had poured through a notch high in the cliff. Branches had been torn from pines by the hurtling boulders. Over all lay a blanket of fine rock dust.

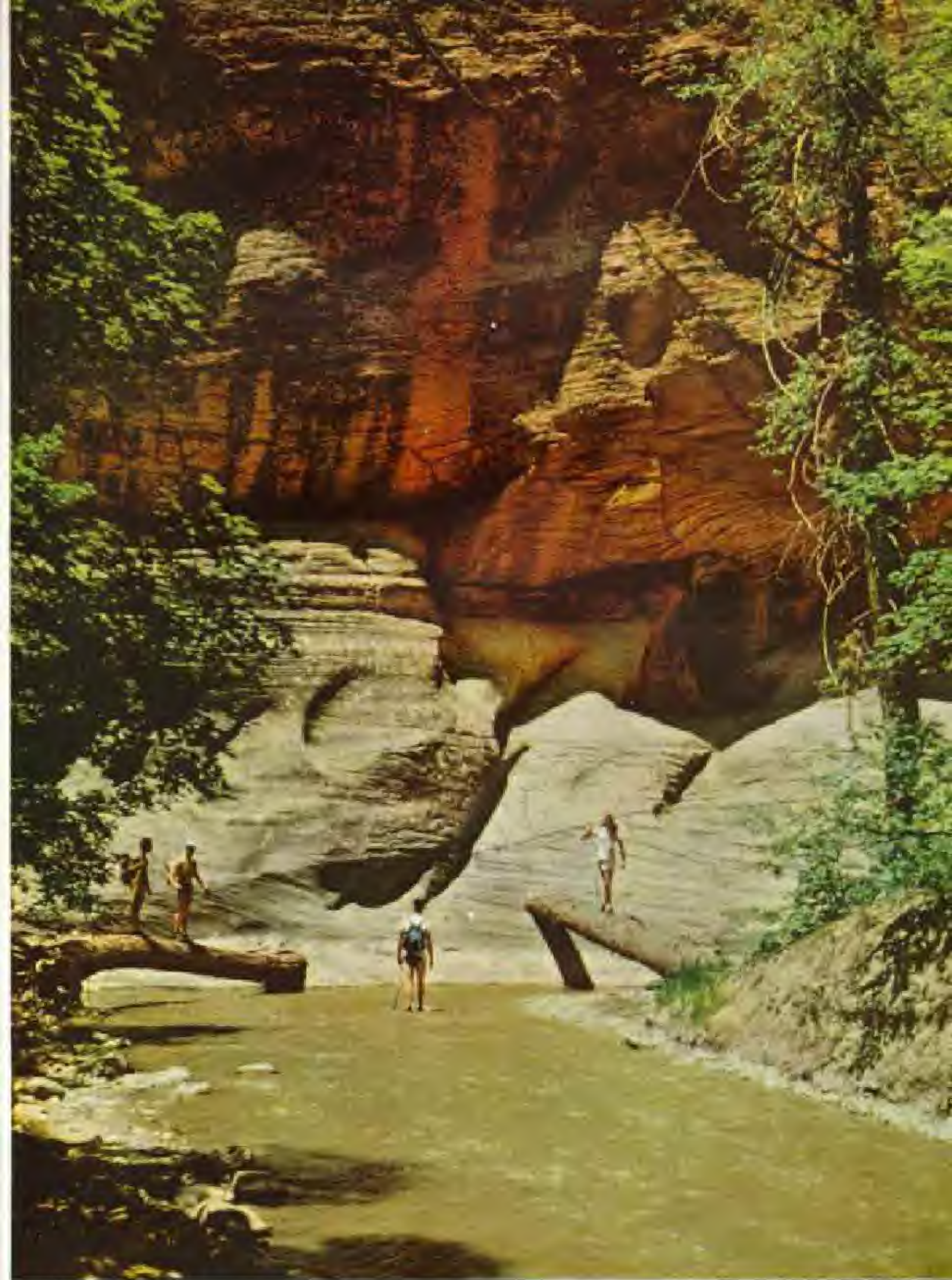
Noon came before we realized it. We made a rite of lunch. Over a natural dam of logs and huge boulders the main stream plunged into an alluring pool, bounded on the far side by irregular cliffs and on the near side by rocks on a sandy beach. A cold spring, partly hidden by spreading ferns, seeped from the east wall. We dived and swam like dolphins, and then lay on warm rocks while the hot sun dried our bodies and soaked into relaxed muscles (page 46).

This fantastic canyon carved deep into the Navajo sandstone of Jurassic time must have been millions of years in the making—yet the thought of it reminded us of more miles of canyon between us and our destination. Spurred by our schedule, we shouldered packs and began the sloshing tramp again.

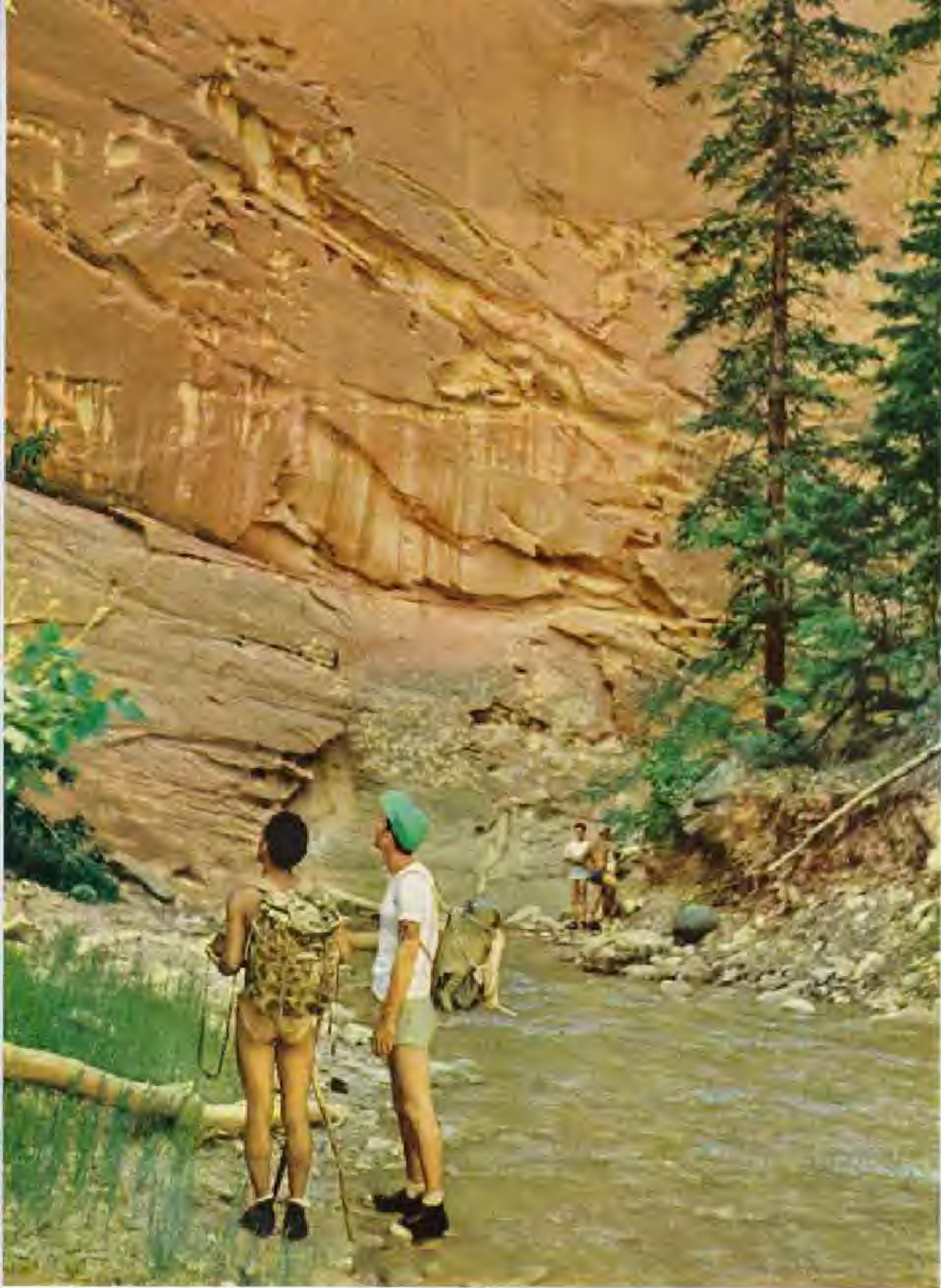
Suddenly, as we rounded a turn, the walls closed in. Here were the real Narrows (page 47). As far as we could see, water filled the gorge from side to side, save for an occasional gravel bar. The walls, generally about 20 feet apart, loomed vertically many hundreds of feet. High up, they receded slightly and continued to soar in a series of ledges.

As we reached the end of the first stretch and made a slight turn, the chasm continued in the same manner in another long passage

(Text continued on page 49)



Millions Have Visited Zion National Park, but Few Have Threaded Its Virgin River Narrows
Walking 12 rugged miles, the author and eight companions followed the Narrows between walls rising up to 2,000 feet. Sudden rain would have trapped them in a torrent. Flash floods left these logs as footbridges.



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42

"A Far Cry from Submarines!" Says a Tattooed Hiker on Navy Leave

Herschel Paradise, on holiday from undersea duty, and Jonnie Serna gaze at a cliff carved by the Virgin River. This buff rock has been stained rust red by overhanging sandstone. Vegetation thrives on the sun's brief daily penetration.



Canyons to Right of Them! Canyons to Left of Them! Time for a Map Conference
Flash floods follow each shower, and tumbling rocks and sand scour the terrain. Each year the river carries 300,000 tons of eroded rock out of the park.



Passing Hours and Seasons Play Color Symphonies on Sculptured Walls

→Sunbeams pour through the knife-cut gorge of tributary Inlay Canyon, highlighting a temple carved by Nature. The sky's blue reflects from stream and stone.





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46

Illustration by Lerita E. Clark

↑ Hikers Wade a Quicksand Pool and Take a Lunchtime Dip ↓

In the entrenched miles from Zion National Park's northeast corner to its Temple of Sinawava (page 56), the Virgin's rushing waters fall 90 feet to the mile. This drop is 10 times as steep as that of the Colorado River in Grand Canyon National Park.

Cliffs Rise Like Massed Skyscrapers → Overhanging Wall Street ←

At points in the Narrows, colorful ledges rise so high they all but hide the sky. Each year's floods dig the rugged chasm a little deeper, but the stream still follows the meanders that it scratched on the plateau's surface eons ago.







Morning Splendor Falls on Pinks and Greens: An Aerial View of the Virgin

From the Narrows, the writhing gorge at upper right, the bikers emerged into the verdant meadow of Zion Canyon (foreground). The final mile to the Temple of Sinawava covered Zion National Park's most popular foot trail.

with no escape ledges. Often the walls overhung the stream 15 feet or so above low water. In places we couldn't see even a patch of sky by which to judge whether the weather was still favorable.

At one point I heard a low gurgling—mysterious and ominous. After a search, I found its source, a spring higher than my head, pouring into a dark pool.

Around a bend the chasm widened, but each side was blocked by immense rocks fallen from the heights. The only way was through the pool, which was too deep to wade. Putting cameras and wrist watches into plastic bags, we plunged into the water. The packs buoyed us surprisingly well. Two of the "frogmen" simply floated their packs, towing them like barges.

Making Friends with Water Ouzels

We were surprised to find several water ouzels, seemingly unconcerned at our approach. Whether through fear or lack of it, one of these small slate-gray birds sat quietly on a branch while we petted it. Another was gently picked up and carried a quarter of a mile. It seemed not frightened but merely curious when placed on the branch of a tree. Endearing birds of spray and foam, water ouzels "fly under water" in search of food.*

Many times we seemed to be splashing through high, vaulted tunnels and passages where, for 40 or 50 minutes of travel, we saw no possibility of climbing off the bottom if the waters should rise.

In some places, we had heard, one can see the stars in midday. We didn't see them; perhaps we didn't look in the right places, or a growing overcast hid them.

Although the riverbed was mostly round stones, from the size of a man's head down to gravel, the going was fairly secure with the aid of our walking sticks. As we stopped for a moment to take the sand from our shoes, welcome sunbeams slanted down from the notch of steep and rocky Inlay Canyon (page 45).

Again the walls closed in. The water became deeper, though not because the stream was rising. The course was more winding. We were traveling a narrow tunnel whose eerie walls echoed and re-echoed our voices.

Then we entered another stone chamber, with flaring rock buttresses on either side. Feeling that we were threading our way between the feet of giant pachyderms, we called it Elephant Temple.

This point, at the junction of Orderville Canyon, was as far as Nate had come upstream on his scouting trip in May. This tributary enters at main-stream level through an even narrower slot from the east; one can touch its walls with outstretched hands.

Where the river makes an almost closed horseshoe bend, we glimpsed the Mountain of Mystery jutting skyward. Then the canyon widened, and on the gravelly shore we saw horseshoe tracks and a gum wrapper. Civilization was near.

At last, seven great bends beyond Orderville Canyon, we heard voices. Across the river were the girls. They had walked up beyond the end of the trail that leads from the loop road in the Temple of Sinawava. We were weary but filled with satisfaction at having achieved our goal.

As we emerged dripping from the river at the trail's end, a group of park visitors looked toward the Narrows from which we had come and listened to the ranger tell of the hazards which lurked there (page 54).

That night it rained lightly.

Several weeks later we heard that a flash flood had inundated the whole canyon at the Temple of Sinawava. The river's volume increased 50 times, most of the rise occurring within about 15 minutes. How I would like to have seen the turbulent gorge then—from a safe perch!

Scas Once Flooded Zion

The Narrows is only one of the sights of Zion National Park. Now that our main objective was behind us, we had time to look at some of the region's other attractions.

Over the ages Zion National Park has witnessed many changes in landscape and climate. Once it lay under fathoms of water. Water pressure and chemical action changed layers of gravel, sand, and lava ash into solid rock, cemented and colored by iron oxides and lime. Embedded in this slowly upthrust rock are fossilized fish, shells, and plant life; here are found the bones and tracks of dinosaurs which disappeared 60 million years ago.

When today's visitors to Zion ask the inevitable question, "How was the canyon formed?" the ranger-naturalist's answer is, "Zion Canyon was carved by the stream flowing through it, the Virgin River. Frost,

* See "Winged Denizens of Woodland, Stream, and Marsh," by Alexander Wetmore, NATIONAL GEOGRAPHIC MAGAZINE, May, 1934.

seepage, and chemical action abet the work of the river."

At the Temple of Sinawava the canyon walls are cut through a layer of sandstone 2,000 feet thick (page 56). Farther down the canyon are steep slopes below towering walls. These majestic cliffs are indented with alcoves, broad amphitheaters, and magnificent arches. Slender pilasters in statuesque form are everywhere.

Formations of six geologic epochs are prominently displayed in Zion Park. The youngest, and therefore the uppermost, is the Carmel limestone which caps the East Temple, West Temple, and the Altar of Sacrifice. This 200-to-300-foot layer, gray to light buff in color, was the floor of the shallow sea, perhaps 120 million years ago.

Beneath is the Navajo sandstone, which in Zion Park is more than 2,000 feet thick. From these great beds have been carved the massive formations, the cliffs and sheer canyon walls that make Zion Park outstanding even in the scenic southwest.

A rainbow canyon, Zion has been called. Lower walls of sandstone, predominantly red, run a full range of purples, blues, and browns in changing light. Higher up, the spectrum pales through pinks, lilacs, and buffs to gray-white. Above all a tap of green forest touches the brilliant blue sky. Rains have blended the colors of Zion into earth-bound rainbows.

First Families Were Basket Makers

Among the early inhabitants of Zion National Park were the Basket Makers. Fragments of primitive fabric woven of fur and fiber bear witness to their presence.

Later, Pueblo Indians lived seasonally in Zion's larger cliff caves while raising corn and other vegetables on the canyon plain. The cave dwellings were outposts of villages closer to the Colorado River. Crumbling remnants of this architecture lie out of motorists' range in cliffs of Pariauwep Canyon.

After the Pueblos came the Paiutes. They too were summer colonists in the Zion region, settling on the plateau as well as along the Virgin River to grow corn and hunt. A peaceful people, they ably guided early explorers.

The first white men in southwestern Utah were probably the Franciscan fathers Dominguez and Escalante. In 1776 these adventurous Spaniards set forth from Santa Fe in an attempt to reach Monterey on the Pacific coast. October snow thwarted their hope of crossing the Sierra. Heading back toward Santa Fe through unknown country, they crossed the Virgin River near Hurricane, 20



50

Drops of Rain Carved Zion, Southern Utah's Rainbow-rock Wonderland

Zion National Park and Monument cover an area the size of Chicago. Last year about 180,000 visitors were attracted to Zion Canyon, which stretches nine miles along the Virgin River's North Fork. To thread the Narrows' deep gorge, the author's party followed a route traveled by few park visitors. This map shows Zion's deeply eroded tableland by a special relief technique employing highlights and shadows.

miles southwest of Zion Canyon. Continuing, they forded the Colorado River at the point since known as the Crossing of the Fathers.

A half century later fur trader Jedediah S. Smith is believed to have traversed what is now Zion National Monument, west of Zion Canyon, in successfully blazing a trail to the Pacific coast. He started south from Great Salt Lake in August, 1826, and reached the Virgin River, as Escalante had done, by descending Ash Creek. Smith named it Adams River in honor of President John Quincy Adams. The Spaniards knew it as Rio Virgen.

There is no evidence that Escalante or Smith ever saw Zion Canyon. Nephi Johnson, a young Mormon missionary and interpreter among the Paiute Indians, was probably the first white man to see its depths. Called by Brigham Young in the fall of 1858 to explore the upper Virgin River, he persuaded the Paiutes to guide him over the rugged escarpment of the Hurricane Cliffs and up the Virgin River as far as the Narrows. His Indian guide



A National Geographic Map
Drawn by Victor J. Kallity
and Robert C. Ellis, Jr.

refused to go any farther than Oak Creek, because *Wai-no-pits*, the Evil One, might lurk in the shadows of the narrow canyon.

The Mormon leaders were convinced of the wisdom of pushing the settlement of southern Utah. Several hundred families settled in St. George, in the Virgin River Valley. Cotton and cattle raising prospered. Tithings were devoted to the erection of a fine tabernacle.

These migrations to Utah's "Dixie" were a prelude to the settlement of Zion and Parunuweap Canyons. Old Grafton, north of the river, named after a town in England, was first colonized in 1859 by Nathan C. Tenny and others.

A huge flood incident to the "great rain" of 1861-62 filled the valley from bluff to bluff. Tenny's wagon-box home, with his expectant wife in it, was carried by men to safer ground. Here his son was born. He was named, appropriately, Marvelous Flood Tenny. To escape more deluges, the settlement was moved to higher ground.

Rockville was established in 1861, a short distance below the present town. The initial settlement was christened Adventure. Here too the great rain convinced the colonizers that they should build on higher ground. In 1862 they surveyed a new townsite and named it Rockville for the many boulders near by. This attractive village continues to thrive.

At the gateway to Zion Canyon, between the red Watchman and spectacular Mount Kinesaya, lies Springdale. Founded in 1862, it has grown to be the valley's principal community and is the postal address of the park.

Three Doors for Three Wives

In the middle 80's, Oliver DeMill built an impressive stone house at Shunesburg. DeMill had three wives, the story goes, and put a door for each in front and in back of his large residence. The second story of this unusual house served for many years as a social center for upper Virgin River settlements.

But grazing on the highlands was excessive. Floods in the Parunuweap washed away farmlands. Families departed. Today Shunesburg and its mansion are deserted. Broken pieces of white man's china mingle in the dust with prehistoric pottery fragments.

In talks with friendly Eivind T. Scryen, for four years Zion Park's superintendent, I heard for the first time many stories of the Virgin River country. Some of these tales are told in the book *The Rainbow Canyons*, which he wrote with Frank J. Taylor.

It was from Scryen that I learned of a strange prophecy and its fulfillment.

The first Mormon pioneers sent to live in the canyon protested the lack of timber for construction use. "Lumber will soar down from the cliffs like an eagle," Brigham Young is said to have told them.

Some 30 years later the prophecy came true. In 1900 mechanical-minded David Flanigan hit upon the idea of a moving cable from canyon rim to floor to bring down the fine yellow-pine timber that stood at the top of the cliff.

Starting out with 50,000 feet of wire, which he stretched between drums at top and bottom, he labored for several years experimenting with pulleys and wire tension. By 1906 200,000 feet of sawed lumber had been lowered down the 2,600-foot cable.

Today's visitor can see the upper tower of Flanigan's cable, still perched atop Cable Mountain, northeast of the Great White Throne.

Settlers Laughed at "Joseph's Glory"

Joseph Black is generally credited with being the first to investigate the upper area of Zion Canyon. In contrast to many of the early settlers, who took their scenery calmly, Brother Joseph brought back such glowing accounts of the beauties of the imposing walls that the canyon was often derisively referred to as "Joseph's Glory."

To another Mormon, Isaac Behunin, we owe the name Zion. Although struggling desperately for a living by raising a little tobacco, garden truck, and a dozen or so head of cattle, he found time to reflect on the scenic riches of his environment. He is reported to have reasoned about like this:

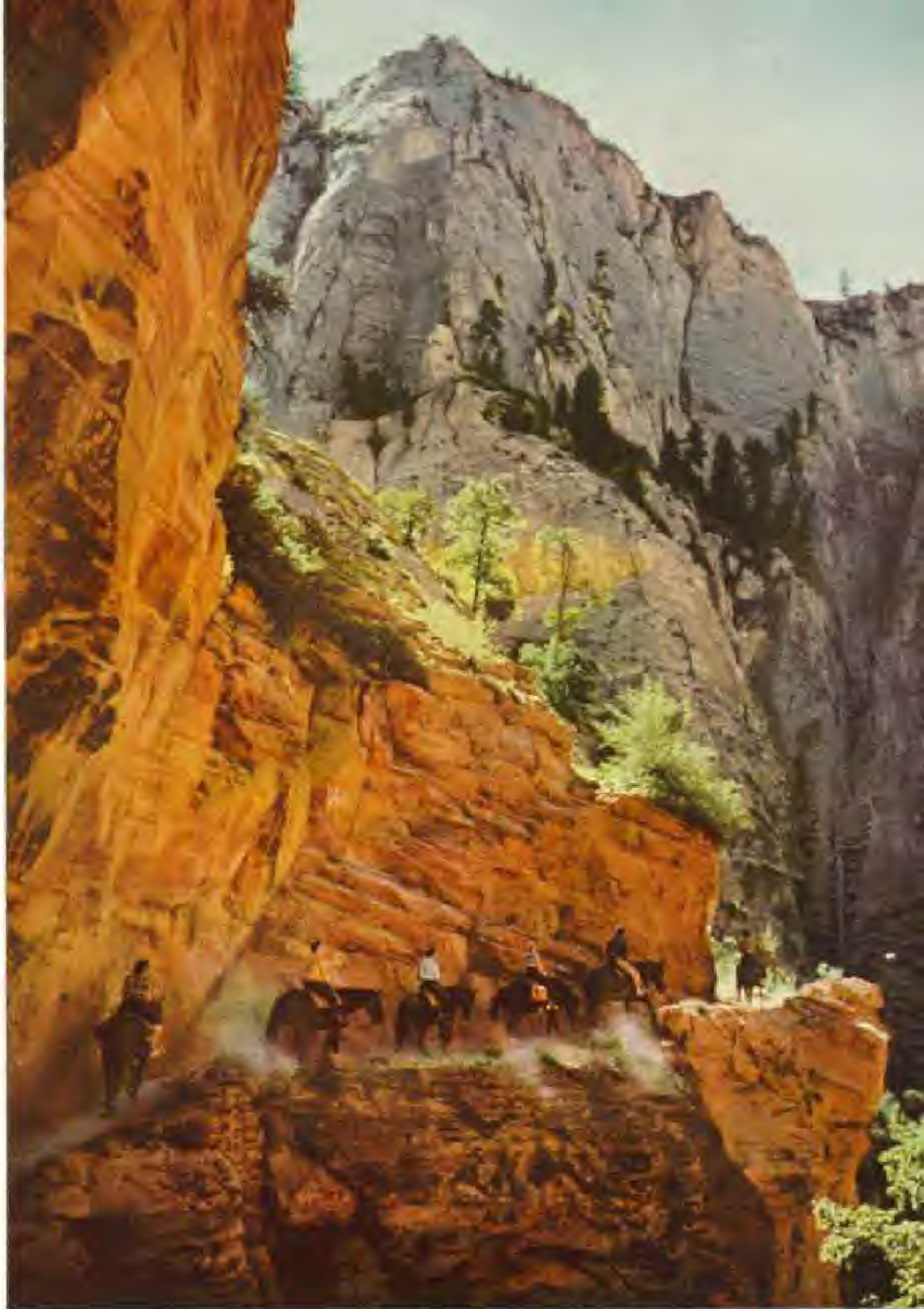
"These great mountains are natural temples of God. We can worship here as well as in the man-made temples in Zion. Let us call it Little Zion."

So it came to be known. But on one of Brigham Young's visits to Springdale, he was told about this Zion and was not satisfied. "It is not Zion," said he. Some of the faithful thereafter called it "Not Zion."

On July 31, 1909, President Taft signed a proclamation creating Mukuntuweap National Monument. Zion Canyon was then still inaccessible.

In 1918 the National Park Service, encouraged by Utah citizens and Congressional representatives, recommended enlarging the

(Text continued on page 59)



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53

Endorsement by Paula Locke

A Pony's Step from Eternity, Sight-seers Climb Zion Canyon's East Rim Trail

Sure-footed mounts follow a path that is rarely more than five feet wide (page 63). The route takes riders $3\frac{1}{2}$ miles from Weeping Rock parking area to Observation Point. Sunshine highlights the bright cliffs.



Campers and Hikers Drink In Grandeur of Zion's Canyons

★ Don Williamson, his wife, and children, of Laguna Beach, California, enjoy breakfast in Grotto Campground. Lady Mountain, on Zion's west wall, rises behind them.

The Virgin River's North Fork, sculptor of the deep, majestic chasm, flows close by. Mormon pioneers discovered the canyon in 1825. They named it Little Zion and turned its sheltered meadow-land for decades. From a small beginning as Mukursi township National Monument in 1909, Zion National Park attained its present 130-square-mile area in 1930.

→ Ranger-naturalist Richard Cook delivers a talk to visitors at the entrance to the Virgin River Narrows. They have hiked an easy mile north from road's end in the Temple of Sinuavava (page 56).

Opposite page: Engineers tunneled through solid rock of massive Reiter Mountain (left) to form the windowed mile-long tunnel of the Zion-Mount Carmel Highway. From the tunnel to park headquarters the highway makes six hairpin turns and drops 800 feet in three road miles.

Pinnacle of the park, distant flat-topped West Temple (left center) stands 7,703 feet above sea level and 3,800 above the canyon stream.



Visitors Atop the Great Arch of Zion Survey the Highway Twisting out of Tunnels Rock down to the Canyon's Floor

55

© Keesel/Armed & Talented







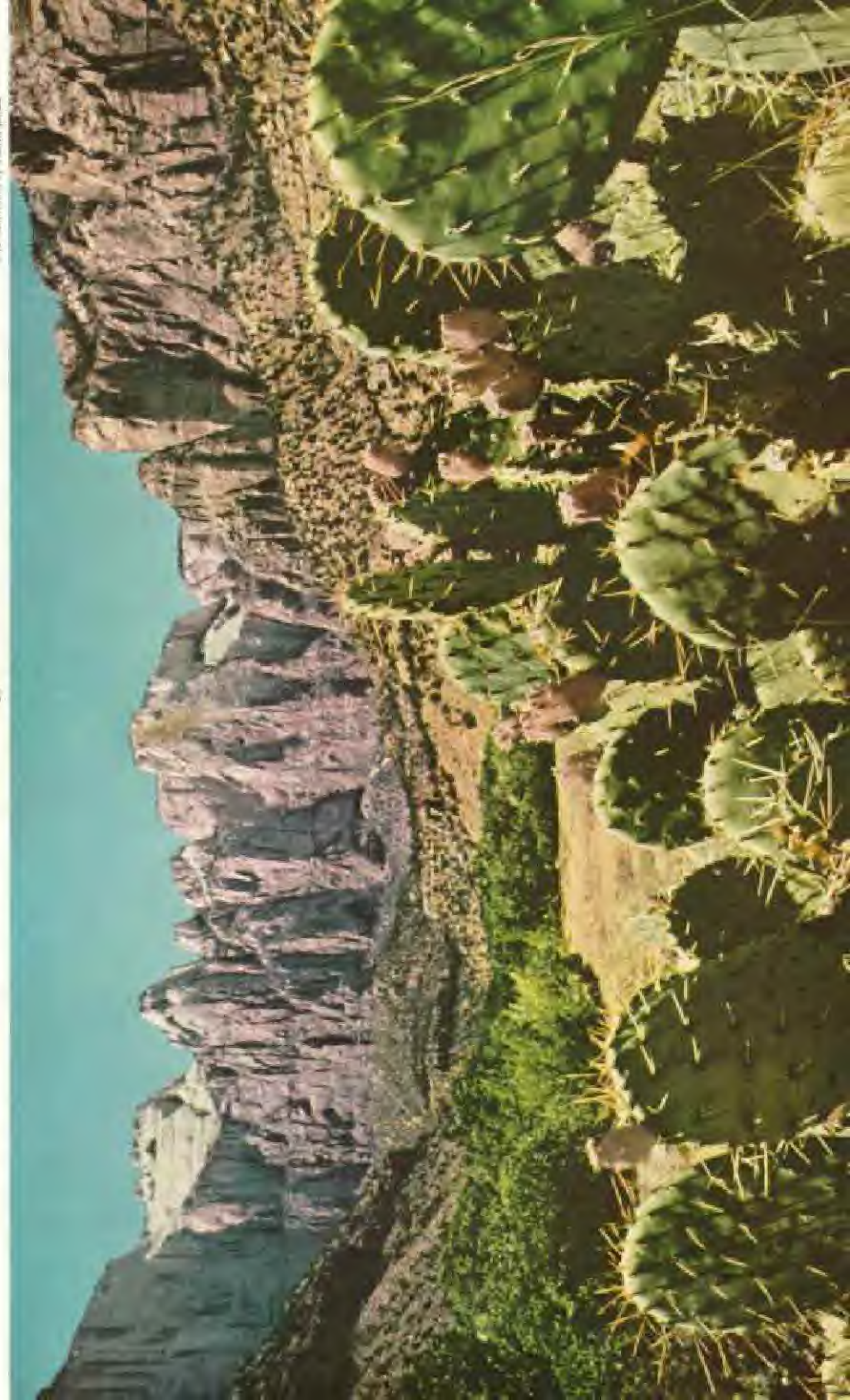
Sight-seeing Buses from Canada Park in Simawaya's Amphitheater Beside the Virgin River

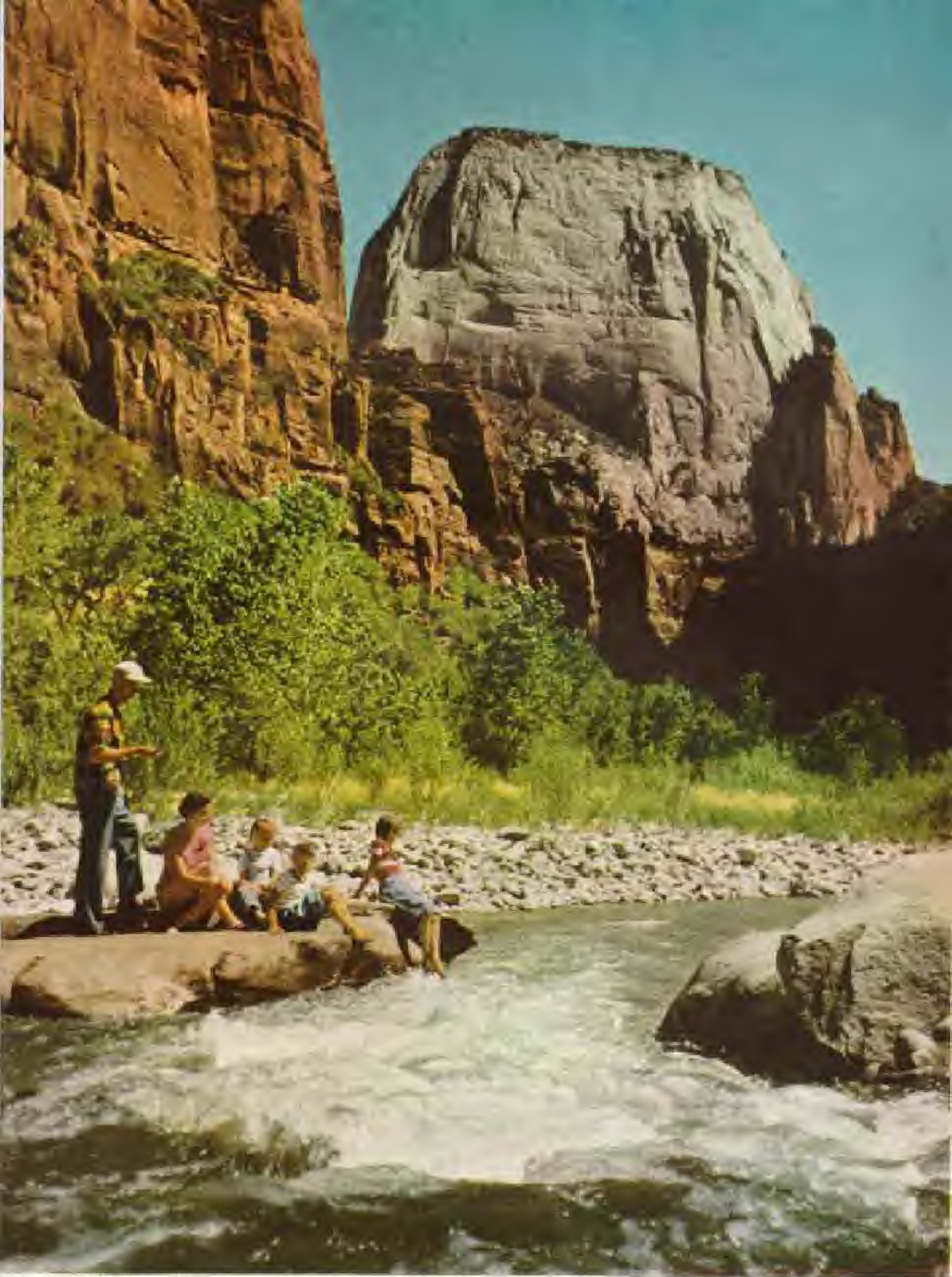


Spines of Cañons Appear to Fence Off Approaches to the Towers of the Virgin on Zion Canyon's West Wall

59

© Wilderness by Justin Leckie





Midday's Bright Sky Frames the Great White Throne

Zion's best-known landmark rises 2,350 feet, or more than four times the height of the Washington Monument, above the Virgin River loaming at its base. The Throne changes colors with the march of sun and seasons (page 58).



Zion Canyon: "The Most Wonderful Defile It Has Been My Fortune to Behold"

Grover Karl Gilbert, a Trustee of the National Geographic Society from 1896 to 1903, gave the description in 1877. He named the Narrows (foreground). Angels Landing (upper center) juts into the canyon.

A Round Trip on Zion's West Rim Trail Takes a Full Day in the Saddle

Zion Canyon and its tributaries have been carved from a formation known as Navajo sandstone, a fine-grained quartz held together and colored by lime and iron oxides. Known for the variety and irregularity of its bedding, the sandstone here shows up in orderly, almost horizontal layers.

Two small caves scar the bluff below the riders. Products of monsoons, some of these holes shelter birds, animals, and insects. Indian pueblo ruins have been found in larger caverns.

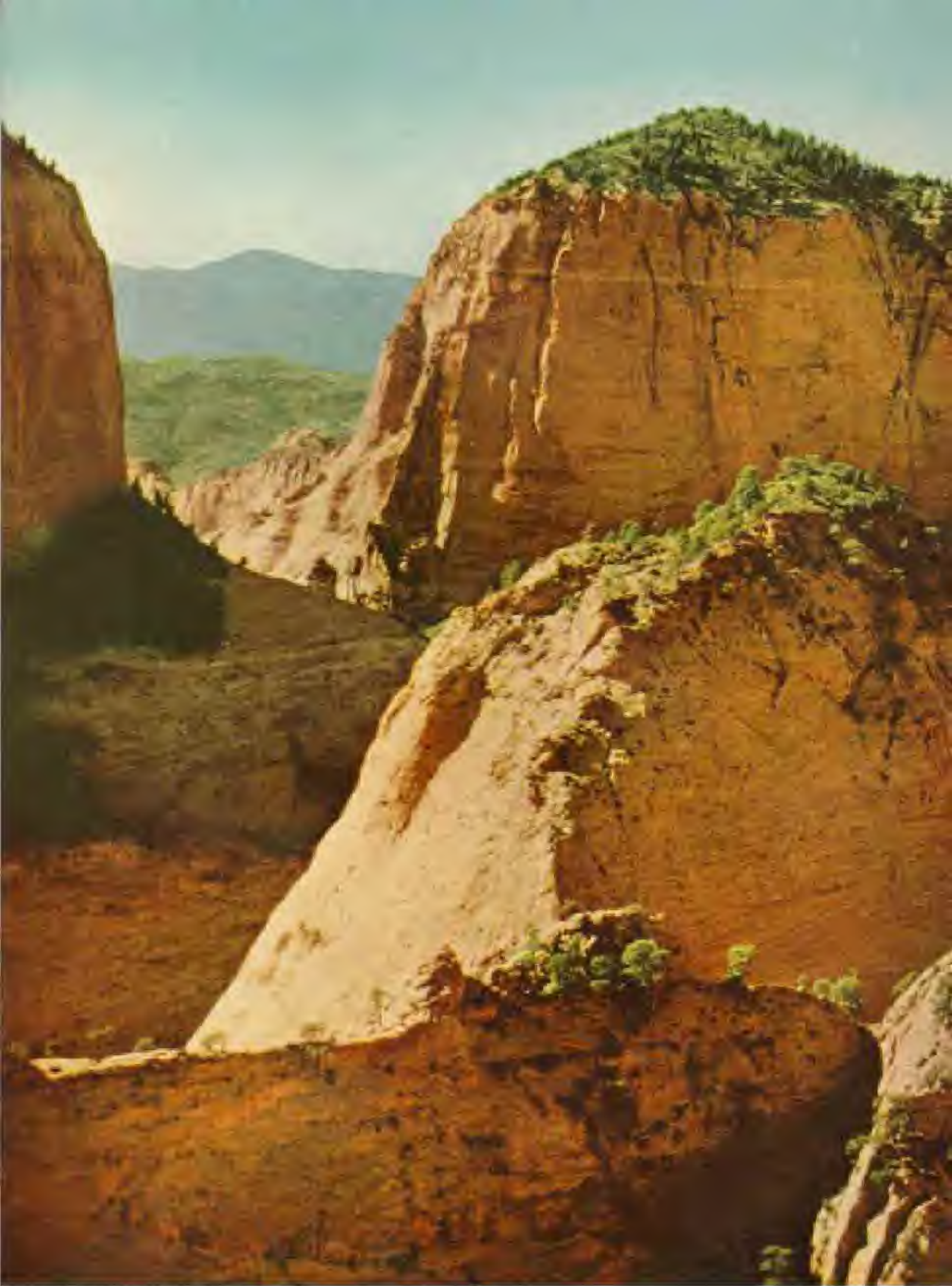
These riders, who pack food and water for eight hours in the open, scan terrain unknown to motorists.

↓ A party near the top of the East Rim Trail passes Cable Mountain (extreme left), so called because the her used to be lowered down its slopes by cable. The riders look toward the Great White Throne (center), Zion Canyon, and the west wall. West Temple's flat top bobs up on the far horizon.

© National Geographic Society







Erosion's Red Domes Wear Green Caps in Zion National Monument

Established in 1937, the 75-square-mile monument adjoins Zion National Park. Canyons almost as deep and narrow as the park's carve spectacular formations in the ancient Kolob Terrace.



An Unspoiled Wilderness Escapes the View of All but a Venturesome Few

Some sections of the monument remain virtually unexplored. Even hikers and riders find it difficult to get in. Wild and majestic scenery compensates for hardships of the trail.





★ **This Natural Bridge
Covers No Stream;
It Leads Nowhere
but to a Blank Wall**

La Verkin Canyon's arch is the monument's wilderness has no official name. It was first climbed and roughly measured last summer by Fred D. Ayres and A. E. Cresswell of Oregon. Comparable in size and vivid color to the great arch in Rainbow Bridge National Monument, 130 miles southeast, it appears to less advantage because it does not arch against the sky.

A rock-awning shelters Russell Varhoe, who guided the photographer,

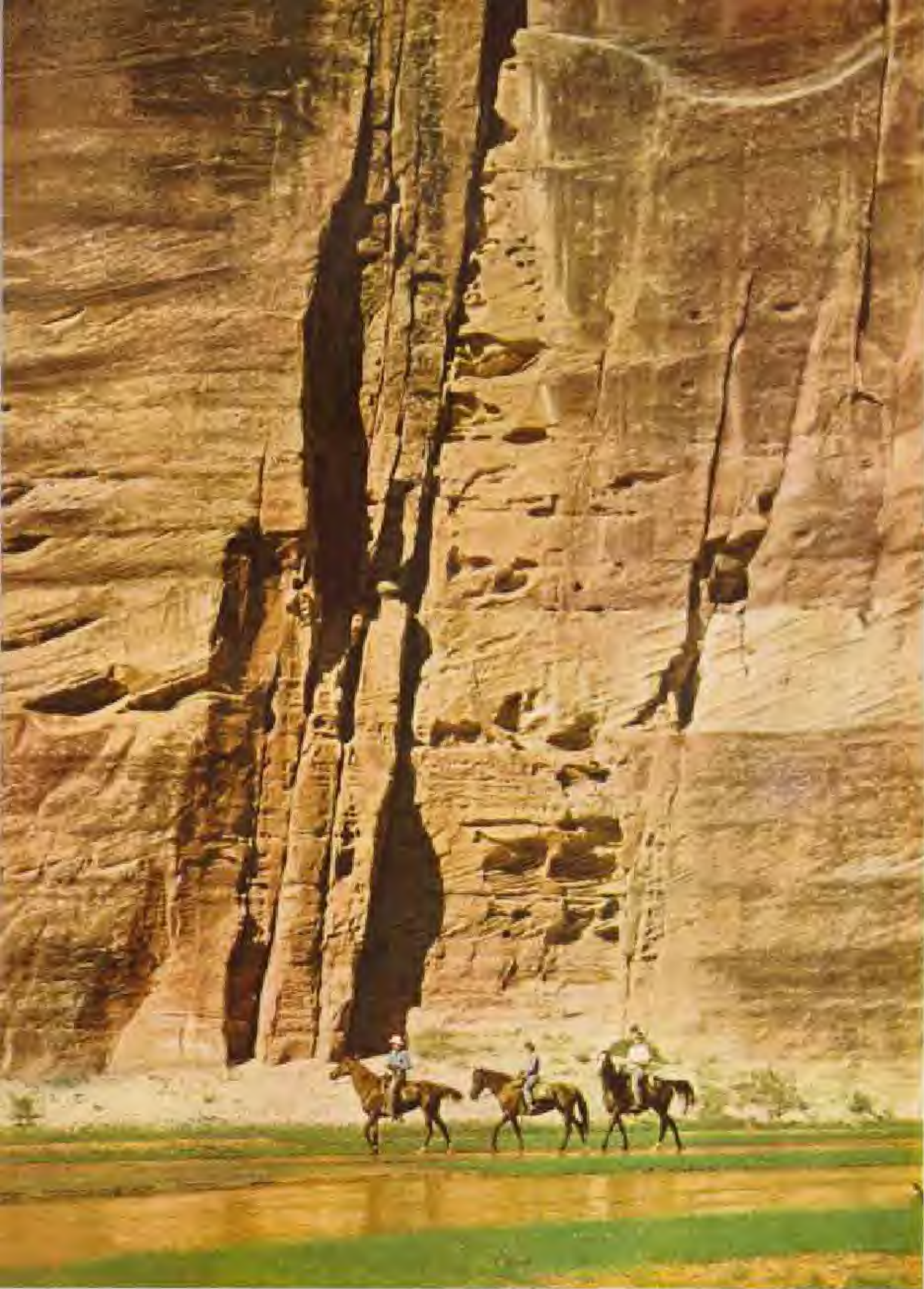
★ Red walls and green foliage frame Triab Point, a purple sugarloaf peak. Like the Virgin River Narrows, upper La Verkin Canyon is a ledge 2,000 feet deep.

★ An exploring party's weary horses refresh themselves from La Verkin Creek.

Leading north from Utah State Highway 13 at the edge of Virgin, the monument's only road is little more than a trail. Hurricane fault, a geological rift to vacationists and geologists alike, lies on the western boundary. A major displacement in the earth's crust, it exposes 2,500-foot cliffs in stratified cross section.

© Washington for Junior Books





A Canyon Wall as Sheer as Masonry Overhangs Hop Creek Valley

Inch by inch, flood waters have dug a mighty ditch deep into the earth. These riders follow a pack trail leading from La Verkin Creek, into which flows Hop Valley's stream.

Mukuntuweap monument and changing its name to Zion. On March 18, 1918, President Wilson signed a proclamation doing this. The next year a bill to establish Zion National Park was signed by President Wilson.

One of the marvels of Zion National Park is the Zion-Mount Carmel Highway, which gives access to the canyon from the east. This road is a masterpiece of both engineering and landscaping.

From the canyon floor, by way of Pine Creek gorge, a series of six great switchbacks climbs in easy grades some 800 feet in three miles (page 55). All are contained in an area of less than one-third square mile!

Then the highway plunges into the north wall of Bridge Mountain. Through a 5,607-foot tunnel it continues its climb to the summit of Zion Canyon's east wall. Six galleries gouged in the rock provided connecting points for boring the tunnel. Now they serve as windows enabling travelers to view the changing canyon scene from rare vantage points.

West Trail Features "Walter's Wiggles"

A prominent feature to be seen from the Mount Carmel Highway is the Great Arch of Zion. One of the largest natural arches in the world, it has a span of 720 feet, is 580 feet high, and is cut 90 feet into the cliffs from which it is formed.

The East Rim Trail is perhaps the most rewarding of the many in the park. From its high points the climber has an eye-popping view the full length of Zion Canyon (pages 53 and 63).

No less spectacular is the longer trail to the west rim (page 62). One of its steeper stretches, known as "Walter's Wiggles," was built by Walter Ruesch, who in 1919 was custodian of the monument that became Zion National Park. Twenty-one switchbacks in 600 feet of canyon-side trail were necessary in order to reach a shelf on the cliff.

My friend Mr. Scoyen reports the remark of a rider journeying over this section: "This is the only place in the world where a horse can be going two ways at the same time all the time!"

High up on Bridge Mountain, across the river from the park's south entrance checking station, is a natural arch slim as a rainbow. This stone remnant of erosion, 156 feet long, leans like a flying buttress against the mountain at an angle of 45 degrees.

In October, 1904, Louis and Samuel Crawford, of Springdale, succeeded in reaching the

bridge. No one else was successful until three members of the Zion Park force reached it in December, 1930. In 1951 two others mounted the slender bridge after bivouacking on the mountain.

Because of the extreme difficulty of the climb, the Zion Park Bridge Club will probably never be overcrowded. This unique feature can be easily seen, however, from several points on the canyon floor.

As you go up the valley, approaching the Big Bend, and crane your neck to see the flat summit of the Great White Throne (pages 58, 60, and 63), the question is, of course:

"Has it ever been climbed?"

For many years this great butte, rising nearly half a mile above the valley, stood as a perpetual challenge to climbers. Then one night during the summer of 1927 rangers saw a signal fire on the top and knew that someone had reached the summit.

The climber remained in a cave until early morning, then started his descent. As he told the story later, he jumped over a small ledge intending to catch a manzanita bush. He missed it. Thirty-six hours later rangers found him, unconscious but alive, at the bottom of a 200-foot cliff.

Nineteen years later a climber attempting to reach the top of the Great White Throne became marooned on a ledge. Rangers were obliged to use ropes to lower the man to a safe spot.

Since then solo climbing has been forbidden. Experienced teams, however, have reached the top and returned without undue difficulty.

Zion Monument a Wilderness

Zion National Monument is separate from Zion National Park but is often confused with it. The deep canyons of upper La Verkin Creek and its tributaries dominate the heart of this 75-square-mile wilderness. North of the La Verkin several smaller canyons cut the southwest edge of the Kolob Terrace. Cliffs and natural carvings in this roadless area blush redder than in Zion Canyon, unseen except by overnight adventurers afoot or ahorse. The heart of the monument is inaccessible to casual travelers.

A jeepable cattle trail that winds north into the monument's wilds is accessible from the village of Virgin, on Utah State Highway 15. It ends several miles short of the spectacular defile where Hop Creek joins the La Verkin.

U. S. Highway 91, the Arrowhead Trail, cuts across a tiny corner of the monument's



Youthful Hikers Take a Breather on Lady Mountain's Flat-topped Summit

Lady Mountain caps Zion Canyon's west wall opposite Zion Lodge (page 34). Some 2,000 feet of cable railing and 1,400 steps cut into solid rock help climbers ascent more than half a mile in two miles of trail.

westernmost projection, giving it a total of less than half a mile of improved road. Hurricane Cliffs rise sharply beside this highway, barring the general view of the monument to the east. By driving three miles westward, toward the town of New Harmony, an excellent view is obtained.

Natural Arch Has No Name

On a shoulder of Timber Top Mountain, north of La Verkin Canyon, a great natural arch rises 152 feet above the canyon floor (page 66). First climbed and roughly measured on August 14, 1953, by Fred D. Ayres, of Portland, and A. E. Cresswell, of Hood River, Oregon, this outstanding Zion Monument sculpture still awaits an official name.

Ceiling of the monument is Horse Ranch Mountain, 8,740 feet, its top a lava field.

Zion National Monument was created in 1937. There is as yet no approved plan for its development, according to Paul R. Franke,

the present superintendent of Zion and Bryce Canyon National Parks. It will probably remain a primitive area for many years to come (pages 64, 67, and 68).

Zion Park's first full-time superintendent, Eivind Scoyen, has moved on to a similar post in California's Sequoia National Park, but his enthusiasm for southwestern Utah's natural wonders is undiminished. His interest in the rainbow canyon extends even to its ultimate fate at the hands of Father Time. The little Virgin River, he told me, carries away about 300,000 tons of pulverized rock a year. Eventually the elements will have their way. The muddy little Mukuntuweap will wash all the cliffs out to sea, and the rainbow canyon will be no more.

The prospect would have pleased one elderly visitor to Zion, Scoyen told me with a chuckle. When asked how she liked Zion Canyon, she said, "The cliffs are wonderful, but they do shut off the view!"

Man's New Servant, the Friendly Atom 71

"Tamed" Atomic Energy Fights Disease, Helps Factories and Farmers, and May Become an Important New Source of Industrial Power

By F. BARROWS COLTON

Assistant Editor, National Geographic Magazine

With Illustrations by National Geographic Photographer Volkmar Wentzel

BEHIND the guarded doors of two strange buildings at Oak Ridge, Tennessee, I saw atomic energy being put to work as the servant of man.

That same morning newspaper headlines had told of tests of new, more terrible atomic weapons.* But here I watched unfolding the brighter, happier story of how atomic energy is building a better world.

Here the same terrific power that explodes atomic bombs has been tamed and harnessed for countless peaceful tasks.

Oak Ridge "Drugstore" Sells Energy

In one big Oak Ridge structure I gazed up with a feeling of awe at the towering bulk of the gigantic atomic pile, or graphite reactor, within whose hidden depths this new amazing energy is unlocked from inside atoms.

In another I was shown the world's first "atomic drugstore," where, if you are qualified, you can buy atomic energy by mail order. This energy is sold and used in the form of elements made radioactive in the atomic pile.

Already atomic energy is at work in the world around you. If you have an overactive thyroid gland, your doctor may give you an "atomic cocktail" of radioactive iodine to slow down the gland's activity and improve your health. If you have a farm, you may be benefiting soon from things atomic energy has revealed about the growth of crops. Your car may last longer because radioactive atoms have helped improve lubricating oils.

Within a few years atomic energy will be running at least one good-sized electric power plant, soon to be built by the United States Atomic Energy Commission. It will produce 60,000 kilowatts of electrical energy, enough to supply a city of 100,000.

Private companies, too, are working on preliminary plans for electric power plants using atomic energy instead of coal. At least one firm already has started a factory to manufacture equipment for them.

In January, 1954, the United States Navy expects to launch its first atomic-powered

submarine, able to cruise submerged for months at a time.† Lessons learned from its operation will pave the way for the use of atomic energy to drive merchant and passenger ships and for making industrial power.

To understand atomic energy, you need to remember first that everything is made up of atoms, much as a house is made of bricks. Each atom has a core, or nucleus, composed of tiny particles, protons and neutrons.

Atomic energy is the potent binding force that holds these particles tightly together within the atom's nucleus. It is so powerful that one atomic scientist has estimated that a piano wire, held together with the same force, could support all the ships of the pre-World War II United States Navy.

This still-mysterious energy is an elusive, almost ghostlike thing. When released it takes the form of rays which cannot be seen, heard, or felt. The rays can be detected only by sensitive counters, which translate them into audible clicks or flashing lights, or by the darkening of photographic film.

If managed with proper care, these rays are as safe and useful as the fire in your furnace or the electric current in an insulated wire, though they can be deadly dangerous if not shielded and carefully handled.

America's Atom Program Is Costly

To date American taxpayers have spent nearly 12 billion dollars on the atomic energy program for both defensive and peaceful uses. In terms of invested capital it is now one of the largest industries in the United States. If not used in war, our radioactive materials stockpiled for making bombs can produce atomic energy for peaceful purposes.

To learn at first hand how atomic energy is working to aid mankind, I visited three of the Atomic Energy Commission's great na-

* For a graphic description of atom-bomb tests, see "Nevada Learns to Live with the Atom," by Samuel W. Matthews, NATIONAL GEOGRAPHIC MAGAZINE, June, 1953.

† See "Our Navy's Long Submarine Arm," by Allan C. Fisher, Jr., NATIONAL GEOGRAPHIC MAGAZINE, November, 1953.



Uranium Atom's Tightly Clustered Core Is the Main Source of Atomic Energy

Shown in Boston's Museum of Science, this model depicts radioactive uranium 235, whose nucleus contains 92 protons and 143 neutrons. Nonfissionable uranium 238 carries three additional neutrons. Both are isotopes, or variants, of Nature's heaviest element. Balls bunched in the center represent the protons and neutrons, which are mysteriously bound together by atomic energy's terrific force. Splitting of the nucleus releases energy far greater than that of any chemical reaction. Wire-strung balls swinging like planets around a sun represent uranium's 92 electrons. Hydrogen, in contrast, has one. True scale would place the outermost electrons 3,000 feet from center.



Metal Hands, Guided by Remote Control, Safely Pour Radioactive Liquids

Materials giving off dangerous rays are handled in atomic energy laboratories by robot apparatus inside special "hot" cells walled with high-density concrete. Using the "master-slave" device, this Oak Ridge, Tennessee, scientist can even turn a screwdriver or write her name. Mechanical limbs reproduce her movements exactly. A zinc bromide liquid between two layers of thick glass protects her from radiation.

tional laboratories—Oak Ridge, run for the Government by Union Carbide and Carbon Corporation; Brookhaven, operated on Long Island by Associated Universities; and Argonne, managed by the University of Chicago. At all three, scientists are doing things impossible before the Atomic Age.

Atomic energy is released from atoms of uranium inside the massive walls of atomic piles, which essentially are giant furnaces.

But an atomic furnace is far different from any other kind. As I walked through a door into the tall hangarlike building which houses the Oak Ridge reactor, I saw looming high above me a cube of pastel-green concrete as tall as a three-story house (page 76).

No sound came from behind the fortresslike walls, no smoke emerged, and no wheels turned; yet I could sense somehow the presence of mysterious forces, unheard and unseen.

Men in long white coats stood by, watching dials and occasionally turning handles. Signs repeated the warning: "Danger. Radiation Hazard." A large one reminded: "If siren

sounds, evacuate building." A technician wearing earphones connected to a Geiger counter moved about on a check for dangerous rays that might escape from the pile.

Atomic Furnace "Burns" Uranium

It was difficult to believe that the most powerful source of energy known to man was being unleashed behind these protective concrete barriers. Yet deep in the interior of the giant reactor billions of uranium atoms were being violently torn apart, creating large supplies of heat and releasing swarms of neutrons, powerful and invisible.

This heat and these swarms of neutrons are the keys to our dawning Atomic Age. Use of the heat to make economical industrial power is still in the future, but already we are using the neutrons to perform an equally important task—making many kinds of elements radioactive, as radium is.

Iron, sulphur, chlorine, and dozens of other elements, when bombarded by neutrons in the Oak Ridge pile, start giving off rays by



44-acre Oak Ridge Plant Processes Uranium for War and Peacetime Uses

To separate fissionable U²³⁵ from U²³⁸, Oak Ridge employs the gaseous-diffusion process in which a gas containing uranium is driven through several thousand sieve-like barriers, each pierced with billions of holes less than two-millionths of an inch in diameter. U²³⁵'s atoms, being lighter and smaller than U²³⁸'s, pass more easily through the strainers. The U²³⁵ thus concentrated is recovered at the end of the processing; it can be used in atomic bombs or as fuel in some reactors (page 59).

which they can be traced wherever they go.

Some doctors say these radioactive elements have done more for medicine, in improving understanding of the body's functions, than anything since the invention of the microscope or the discovery of germs.

Elements made radioactive in an atomic pile are called radioactive isotopes or radioisotopes.

Isotopes are atoms all belonging to one element, such as cobalt or phosphorus, but differing slightly in weight because they have varying numbers of neutrons in their nuclei. For example, "normal" cobalt atoms have 27 protons and 32 neutrons, but isotopes of cobalt may have from 28 to 37 neutrons.

"Isotope" comes from two Greek words, *isos* (same) and *topos* (place), which means

that, though isotopes of any one element differ in weight, they all have the same chemical characteristics.

Isotopes placed in a pile absorb enough extra neutrons in their nuclei to make them unstable, and therefore radioactive. Radioisotopes of individual elements are called radioiron, radiocobalt, radiogold, and so on.

If a little radioiron is mixed with ordinary iron, all the iron then can be traced wherever it goes inside a man's body, an animal, an insect, a growing plant, or a manufacturing process, to learn what happens to it and how it behaves. With a sensitive Geiger counter one can detect and follow the rays coming from within, learning whether the iron goes to the man's right arm, the plant's leaves, or

Helmet Protects Technician from Contaminated Air

Brookhaven National Laboratory maintains this room at Upton, Long Island, for the decontamination of used equipment. Since the atmosphere may contain particles emitting dangerous rays, pure air is pumped into the worker's helmet.

White coveralls, plastic cape, and rubberized gloves protect clothing and skin from "hot" material. Radioactive waste goes down the drain into tanks where it is stored until it expends its dangerous energy. The steel and lead "hot pot" transports radioactive liquids.

His work finished, this man will check hands and test with a Geiger counter. Coveralls go to a special laundry.



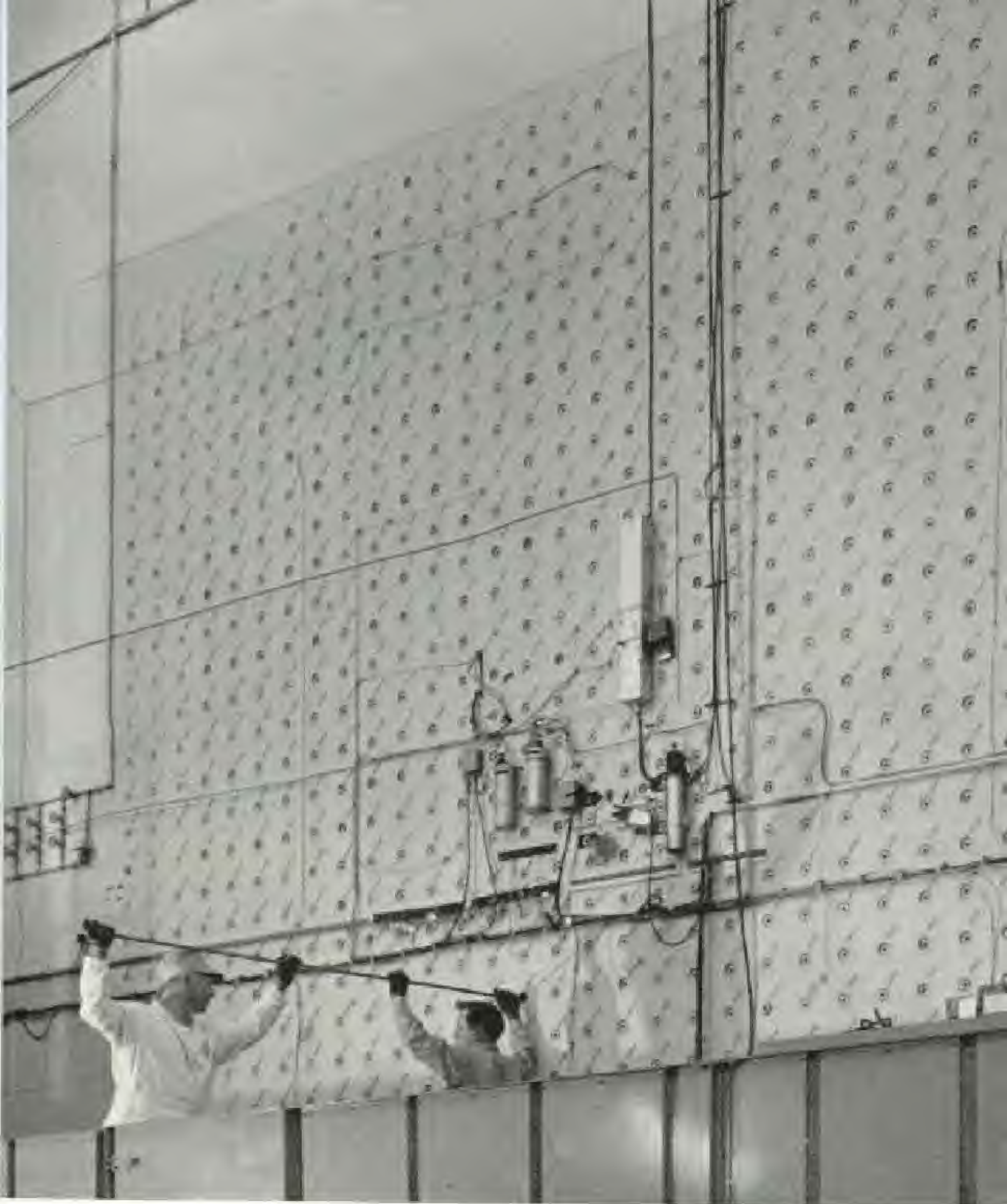
"Fido," a Rolling Geiger Counter, Sniffs Out Danger

If Brookhaven's "hot" materials were spilled unwittingly, they could endanger the health of workers; small but dangerous amounts might even be tracked into homes.

This operator makes a routine check of the floor in the "hot" laboratory.

Clicks sounding in the earphones suddenly increase if Fido discovers menacing radioactivity. A lead cylinder around the counter's nose screens out natural radiation which might confuse the count.

Workbenches, walls, and equipment are checked periodically with other instruments. Workers wear detection devices that record their exposure. These and other precautions have given atomic energy installations a high safety rating.



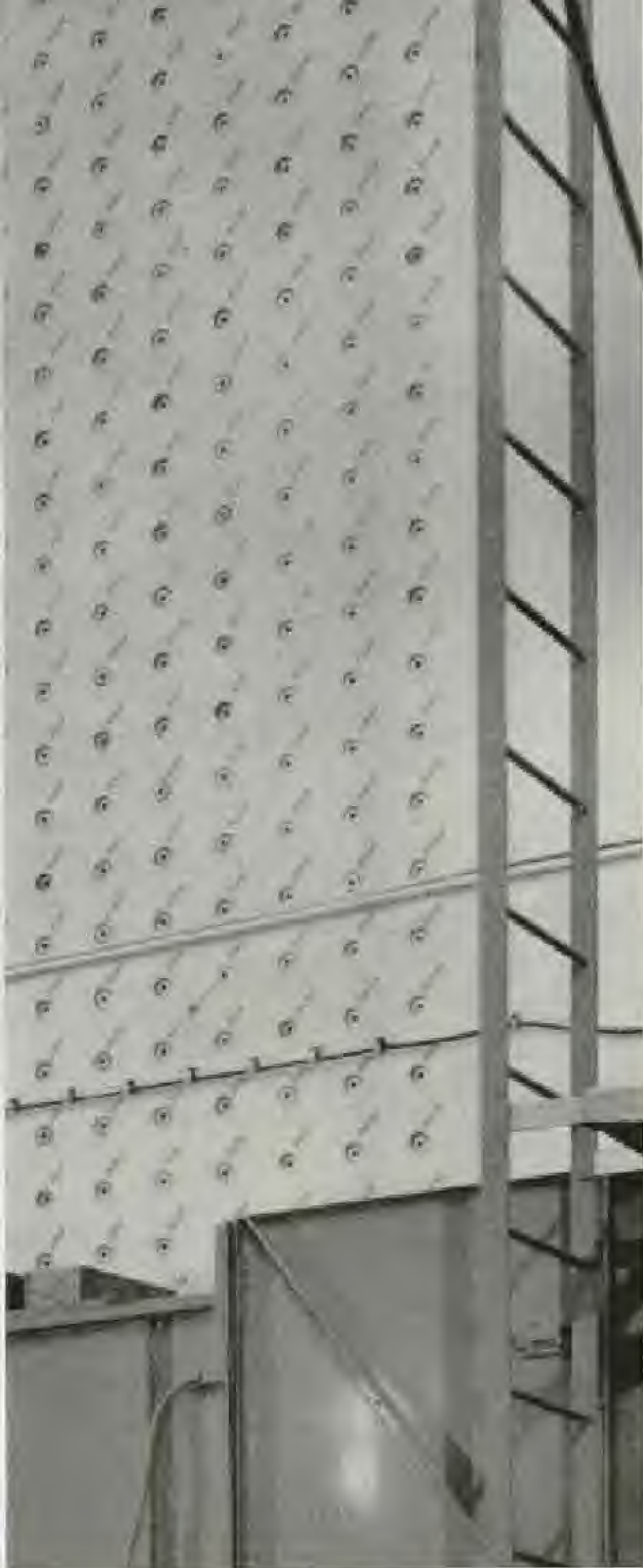
the insect's wings or legs. It is somewhat like locating a clock by listening for its ticking.

In the Korean War radioactive carbon helped indirectly to save lives. It showed doctors that they could safely use dextran, a substance made from sugar, as a substitute for human blood plasma. Dextran is preferable because it can be manufactured in unlimited quantities and offers no risk of giving

a patient yellow jaundice or hepatitis, occasionally spread by human plasma.

When dextran was first developed, doctors hesitated to use it because about 35 percent of a dose disappeared after injection. They feared this missing portion was lodging somewhere in the body and might be harmful.

Then doses were made up with radiocarbon mixed with the ordinary carbon that forms a



part of dextran. When given to human volunteers, this dextran was traced in their bodies with Geiger counters, revealing that the missing 35 percent was being harmlessly exhaled.

Up to the present time almost a million pints of dextran solution have been manufactured for the military services, and large quantities are being produced for civilian use. Dextran, however, cannot substitute for red

Workers Ram Home a Uranium Slug in Oak Ridge's Atomic Pile

The Oak Ridge pile was built to transmute non-fissionable U238 into fissionable plutonium (Pu239) for atomic bombs. Today it is the world's chief producer of radioisotopes for use in science and medicine (page 81). The reactor's 7-foot-thick concrete outer wall conceals an actual pile of graphite bricks. These slow down the neutrons emitted by fissioning uranium, making possible the atomic chain reaction. Neutron-absorbent boron-steel rods are inserted or withdrawn to control the pile.

These operators, working on an elevator platform, insert uranium into one of 1,248 openings for slow and safe production of energy. Other channels receive unfissionable materials to be made radioactive.

E. A. Atomic Energy Commission

blood cells, so its advent does not reduce the need for donations of whole blood.

Radioisotopes made in the Oak Ridge pile are sold at the atomic drugstore, which since 1946 has made more than 49,000 shipments to 1,742 purchasers in this and 37 foreign countries. Other piles, at the Brookhaven and Argonne National Laboratories, also make some radioisotopes.

The atomic drugstore is a far cry from the one where you buy aspirin or ice cream sodas. You can see its stock in trade only by looking in a mirror. Visiting it, I entered a high-ceilinged room divided down the middle by a concrete wall, six feet high and two feet thick. A tilted mirror above the wall reflected behind it big concrete "chests" with ranks of metal drawers, and strange robotlike gadgets with jointed metal arms and fingers.

"We keep our isotopes behind that barricade, handle them only by remote control and look at them only indirectly, in the mirror," said my guide, "because the concentrated radiation from them otherwise would be dangerous. The small amounts we send out to our 'customers,' however, are quite safe when properly handled.

"We're learning to live with atomic energy, just as we do with fire and electricity. We do not fear it, but we respect it. Watch and I'll show you how we fill an order."

Radioactivity Rings Bells

My guide turned a crank and in the mirror I could see one of the big drawers, filled with small bottles, roll open behind the wall. Instantly a startling clangor of alarm bells filled the room.

"Those bells are set off by radioactivity bouncing over the top of the wall," he explained. "Geiger counters detect it and sound the alarm just as a reminder not to leave the drawer open too long."

He operated other controls, in the mirror



78

University of Chicago's Giant Gun Fires X-ray and Electron Bullets at Cancers

This two-million-volt Van de Graaff generator is one of many atomic weapons enlisted in the fight against intractable disease at the university's Argonne Cancer Research Hospital, which was built with funds from the Atomic Energy Commission. To avoid overexposure, the operators work behind windowpanes containing a shield of zinc bromide liquid (page 75). The model simulates a cancer patient undergoing treatment.

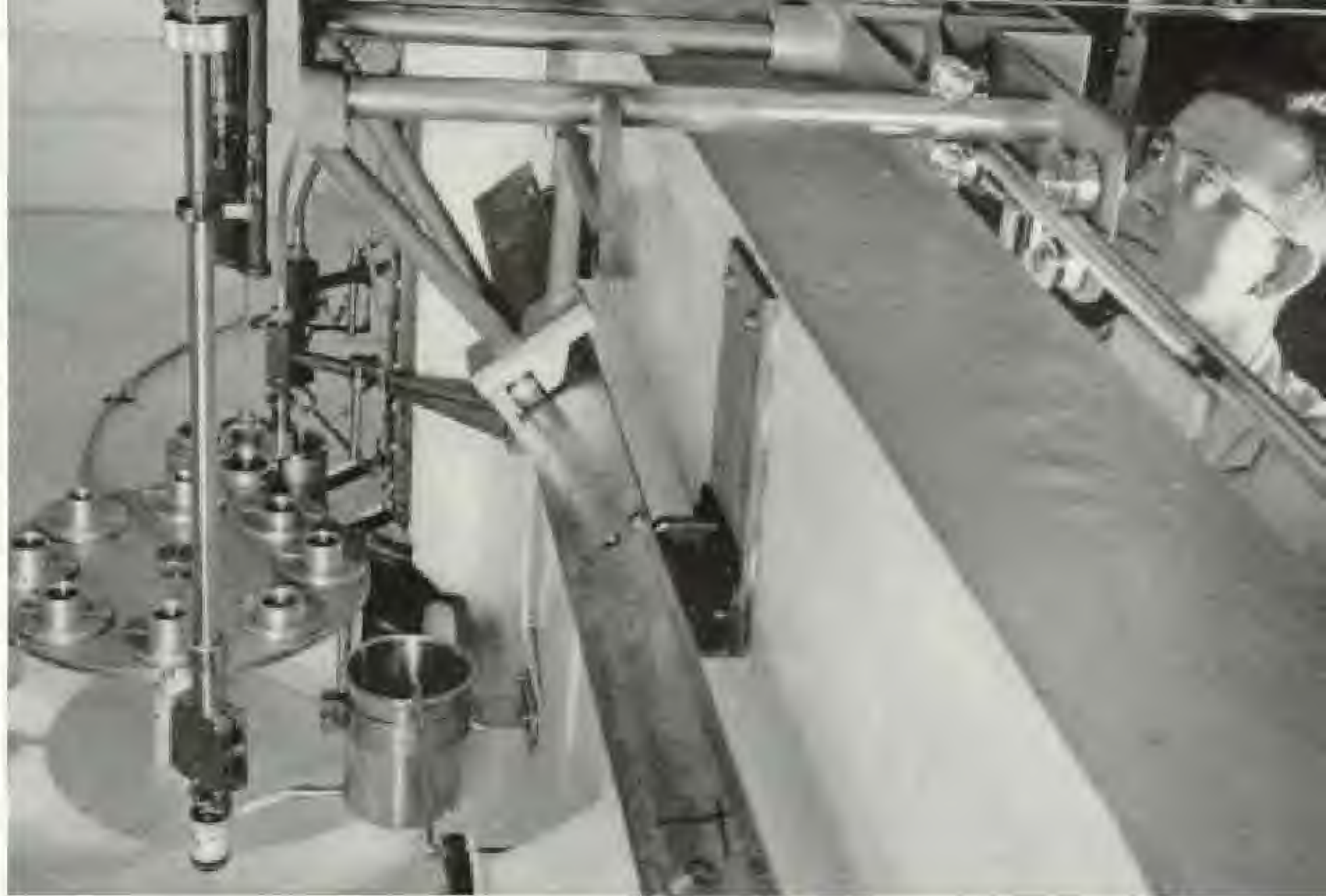
I saw the robot "hands" respond, lifting a bottle from the drawer. With uncanny precision other devices uncapped the bottle, removed a thimbleful of radioactive liquid with a glass pipette, and squirted it into a smaller bottle. This bottle was placed in a sealed lead container to confine its radiation, then boxed for shipment (opposite page).

A little of a radioisotope goes a long way. The radioactive material in an average shipment from the atomic drugstore weighs less than the pencil lead used in writing your name. A year's production of radioisotopes at Oak Ridge weighs less than a tenth of an ounce, but its radiation equals that from five pounds of radium and is made available to users at a tiny fraction of radium's cost.

The rays from various radioactive materials vary greatly in strength. Alpha rays will not penetrate the human skin; beta rays are stopped by a thin sheet of metal or plastic; but gamma rays will go right through a man's body as do X rays.

All of these rays eventually die away at predictable rates. Rays from some elements diminish by half in only a few seconds; others take a few hours, days, or weeks. But rays from uranium have a "half-life" of trillions of years. That is why uranium ore, laid down in past geologic ages, can still be detected by prospectors' Geiger counters.

Constant vigilance is needed in using radioactive materials, because their damaging action is so insidious. A careless worker could absorb a dangerous



Oak Ridge's Atomic Drugstore Handles Radioisotopes Behind Thick Walls

Looking into an overhead mirror (not shown), this technician uses a remote-control device to pick up a bottle of radioactive material. Brief exposure to this sample offers little risk, but prolonged absorption of the rays would prove dangerous. Shielded in a lead box, the material will be shipped to use at the hospitals, laboratories, or industries using atomic energy for medical treatment, research, or factory production.

or even fatal dose of the rays without knowing it until too late. When using radioisotopes as tracers or to treat disease inside the body, scientists and doctors employ only those whose rays will die away fast enough so that they are not dangerous to the patient. It is somewhat like drinking only coffee that is not hot enough to burn you.

People who work constantly with strong radioisotopes or around atomic piles wear special clothing which is washed daily to remove any radioactive substances. They bathe carefully and check their bodies with counters to make sure there is no radioactive material on the skin.

How "Chain Reaction" Works

So far, atomic energy can be released in usable quantities for peacetime purposes only from uranium and plutonium, which are naturally radioactive. The nuclei of such atoms are unstable, spontaneously breaking apart or fissioning. In the process neutrons fly out, the nucleus breaks into two parts, and rays are emitted.

Atomic energy is liberated when a neutron flying out from a uranium atom strikes and

fissions the nucleus of another uranium atom. Neutrons in this nucleus in turn fly out and strike the nuclei of other uranium atoms nearby. Still more energy and still more neutrons are thus released, and in turn split other nuclei, freeing yet more energy and neutrons. This is the so-called "chain reaction."

Much the same thing happens when you strike a match. The friction produces enough heat to raise the temperature of some of the material in the match head so that it reacts chemically and releases more heat. The heat causes more chemical reaction, more heat, and so on until the match head is blazing.

An atomic chain reaction starts spontaneously when enough uranium is gathered together so that at least one neutron from each fissioning nucleus is sure to strike and fission another nucleus. When a chain reaction is allowed to continue unchecked, energy is released so fast that a terrific explosion takes place. This happens in an atomic bomb.

The chain reaction can be slowed and controlled by mixing graphite or bismuth with the uranium. These substances absorb some of the neutrons released in the chain reaction so that it moves more slowly, somewhat as



Like Flies on a Cheese, Men Inspect a Huge Ball Used in Testing an Atomic Engine

This steel sphere was erected at West Milton, New York, to try out the prototype of a power plant that General Electric will build for *Sea Wolf*, second of the Navy's atom-powered submarines (page 89). Should radioactive materials leak from the reactor, the ball's inch-thick skin will seal them in, protecting the countryside. For testing, the engine will be encased in a section of submarine hull sunk in a tank of water. These men stand atop the equivalent of an 18-story building. Forty feet of the 223-foot ball rests below ground.

the moisture in damp wood makes it slower to burn.

A large atomic reactor or "pile" actually is a pile of graphite bricks containing spaces in which slugs of uranium are inserted. Rods of boron steel also can be pushed in to absorb neutrons and regulate or stop the chain reaction. The fissioning of the uranium atoms still produces heat and neutrons, but moves too slowly to cause an explosion.

Pile Realizes Alchemists' Dream

It takes months to release as much energy in a pile as an atomic bomb expends in one split second.

Elements that are to be made radioactive are placed in metal cans, pushed into holes

in the pile with long rods, and left there for a time. In some cases, the bombardment of neutrons changes one element into another, the process of transmutation which the alchemists of the Middle Ages sought in vain.

An important advantage of radioisotopes is that they can be detected in quantities far smaller than any chemical test will reveal.

Friction tests at Massachusetts Institute of Technology show that by making a metal radioactive it is possible to detect the transfer of only one one-hundred-billionth of an ounce from one surface to another.

Putting this knowledge to work, an oil company had some piston rings made radioactive and installed them in test engines. The tiny amounts of steel worn off the rings by

friction and deposited in the lubricating oil could be detected easily with a Geiger counter. The oil that showed up with the least amount of radioactivity obviously was most efficient in preventing friction.

From such tests have come improved motor oils now on the market. The tests also showed, incidentally, that high-speed driving on the highway causes only about a third as much wear on piston rings as city driving.

Cobalt metal, after being bombarded in a pile, gives off powerful radiations like X rays. These cobalt units are far easier and cheaper to make and use than X-ray machines. Their rays can be used to treat cancer (but so far not to cure it), to locate hidden flaws in castings and welds, and to learn how animals are affected by radiation—a clue to its effect on humans in case of accidental exposure or atomic-bomb attack.

"Tagged" Atoms Boon to Medicine

"For doctors and medical researchers, radioisotopes provide an almost magical tool for learning more about how the human body works and how its functions are altered by disease," Dr. Charles Dunham, of the Atomic Energy Commission's Biology and Medicine Division, told me.

"Vitamins, minerals, sugars, medicines, and even secretions of the adrenal glands can be tagged with radioisotopes and traced in the body to learn where they go, how they are utilized by the system, and the changes they undergo. It is almost as though the body were made transparent.

"Injecting radionadium into the body has revealed, for example, that salt travels so fast to the tissue fluids that some of it emerges again in perspiration in only 75 seconds. It goes more slowly to fluids of the eye and spinal cord, slower still to bones and teeth.

"To test how efficiently a patient's heart is pumping blood, radioactive material may be injected into the blood stream and its course traced with Geiger counters. Radioiron has been used to tag red blood cells to learn where they go in the body.

"Bedridden persons sometimes have poor circulation in legs and feet, with a risk of blood clots forming. If radioisodium is injected into the blood stream, the clicks of a Geiger counter will show how fast blood is reaching the right foot as compared with the left. If an artery is blocked, a Geiger counter may help locate the site of obstruction by revealing where blood flow is shut off."

Doctors hoped at first that radioisotopes would be useful in curing cancer, but so far only a few of these hopes have been realized. One difficulty is that radioactivity can damage normal tissue. If a radioisotope stays in a healthy vital organ too long, it can create serious trouble and even cause cancer. Radioisotopes have arrested some cancerous growths, however, and have alleviated pain.

One method of treating brain tumors, though it so far has saved no lives, is a spectacular demonstration of what atomic energy can do. When boron is injected into the blood stream of a person with a certain type of brain tumor, it concentrates in the growth. A few people having tumors that could not be removed by surgery have been given injections of a non-radioactive isotope of boron.

The patient is placed directly on top of the atomic pile at the Brookhaven National Laboratory, Long Island. Through an opening in the pile, a beam of neutrons is released. It enters the skull and the brain, directed as precisely as possible toward the area in which the tumor is located. In the tumor the boron captures neutrons and becomes radioactive, giving off alpha rays which attack the growth from within.

Lives of patients so treated have been prolonged up to several months, and their pain often relieved. Autopsies show that in every case some of the tumor has been destroyed. Doctors hope that ultimately tumors can be completely arrested by this treatment.

Tracers Help Locate Tumors

Radioactive phosphorus and arsenic also tend to concentrate in certain types of brain tumors more than in healthy brain tissue. Injected before an operation, they go to the tumor and send out rays which reveal to the surgeon the location and size of the growth. Even during the operation, tiny probes inserted in the brain tissue and connected to counters help locate bits of tumor the surgeon is unable to distinguish clearly, since all the diseased tissue "soaks up" the radioactive material.

When iodine enters the human body, it concentrates within 24 to 48 hours in the thyroid gland. This gland, in the neck, governs the body's metabolism. An overactive thyroid can so overstimulate a person that nerves are put on edge, weight is lost, and the heart is unduly burdened. Radioactive iodine likewise concentrates in the gland and often helps to slow thyroid activity.



82

Radioactive Iodine in a Calf's Thyroid Reveals How the Gland Is Functioning

How the thyroid is affected by injections of thyroxin is indicated by a ray-detecting Geiger counter held against the animal's neck. Thyroxin, sometimes given to cows, slows thyroid activity, makes the animals placid, and diverts energy to milk production. University of Tennessee conducts this test at Oak Ridge to determine the permanent effects of thyroxin. Lacking injections, the second calf provides a standard of comparison.

Leukemia, in which the body produces too many white blood cells, sometimes is helped by radiophosphorus, but so far has not been cured. Skin cancers have been cured by soaking up radiophosphorus in pieces of blotting paper taped over the cancers.

Where possible, doctors prefer to treat internal cancers without using X rays or other radiations from outside, which may damage the healthy tissue through which they pass to reach the cancer. Wires, needles, or beads of radioactive gold, cobalt, and other elements can be inserted in cancers to attack from within.

Unfortunately, some unscrupulous persons have taken advantage of the wide publicity about atomic energy to advertise fake "cures." Thousands of people suffering from arthritis and kindred conditions paid fees to enter an abandoned uranium mine in Montana under the false impression that the radiations there would help them. The same promoters sold small sacks of uranium ore by mail until the United States Food and Drug Administration stopped the practice.

In well-kept barns of the University of Tennessee's Farm Research Project near Oak Ridge, Dr. C. L. Comar showed me cattle he injects with radiocalcium to test how the skeleton makes use of ordinary calcium.

Calcium Traced in Bone Growth

"As an animal grows," he said, "calcium from its food travels to the regions of the bones where growth of the skeleton takes place. The amount of radiocalcium that collects in the bones can be measured and shows how much ordinary calcium is used in growth.

"If an unborn calf gets too little calcium by normal processes, it draws what more it needs from the mother's bones, showing that both bovine and human mothers should have plenty of calcium in their diets during pregnancy.

"Tests with radiocalcium also have shown that in old age cattle excrete more calcium from the bones than they are able to absorb from the diet. This may also happen in humans, perhaps explaining why the bones of



High School Students Make Their Own Geiger Counters to Study Atomic Energy

Heart of a Geiger counter is a tube filled with gas. Rays from radioactive atoms penetrating the gas produce electrical discharges that flash lights, move dials, or cause clicks in a loud-speaker. The frequency of clicks indicates the degree of radioactivity. This science class assembles detectors at Erasmus Hall High School, Brooklyn. Using one, the girls count rays given off by a plant containing a radioactive element.

elderly people tend to be weak and brittle."

Another Oak Ridge scientist used radioisotopes to study how hens make eggs and how the eggs grow. He fed hens radioactive mash, then followed it with counters as it moved inside the birds. He found that a new-laid egg contains material from feed the hen ate as much as 40 days before. A complete egg takes eight to ten days to form, with about seven days for the making of the yolk. But nearly 75 percent of the shell comes from feed the hen ate the previous day.

By making elements in fertilizers radioactive, scientists have gained new information about how crops utilize plant foods.

North Carolina tobacco growers now are saving every year the cost of some 4,300 tons of superphosphates they formerly used. Tracer experiments showed tobacco plants were taking up almost none of this fertilizer.

Corn plants, it has been found, use phosphorus from fertilizers in the first stages of growth, but later draw most of their phosphorus from deposits already in the soil.

Potatoes, however, use phosphorus from fertilizer throughout the growing season.

Plant explorers have combed the world to find new varieties of food crops resistant to disease or drought. Nature makes these varieties through mutations or changes in the genes that govern heredity. Mutations in Nature are rare, but now, with strong doses of radiation, their rate of appearance can be speeded up. This increases the chance of developing useful new varieties quickly.

Radiocarbon Tags Digitalis

Dr. Norbert J. Scully, Division of Biological and Medical Research, Argonne National Laboratory, showed me his small greenhouse in which plants grow in controlled air containing carbon dioxide tagged with radioactive carbon.

"Plants in the greenhouse absorb the radiocarbon, and it then can be traced in the plants and in products made from them," he explained.

"For example, digitoxin, the heart stimulant, is made from leaves of the foxglove plant, of the genus *Digitalis*. Doctors until recently



Life's Built-in Atomic Clock, Radioactive Carbon, Dates Ancient Remains

Carbon dioxide absorbed from air by plants contains radioactive carbon. When animals or humans eat the plants, the isotope enters their bodies. During life it gives off an average 16 rays a minute per gram of carbon. At death its radioactivity begins to slow down at a fixed rate. After 5,000 years, the element's half-life, eight rays a minute escape; four after the next 5,000; and so on. Hence the count reveals how long ago the death occurred. Dr. Willard F. Libby, seen at University of Chicago, developed radiocarbon dating. Mummy mask from 680 B. C. and textiles from 1300 B. C., dated by older methods, serve as checks on his work.

had no way of knowing how much digitoxin was actually used by the body and how much was unused and excreted.

"We grew foxglove in the greenhouse, and the plants absorbed radiocarbon.

"In cooperation with Dr. E. M. K. Geiling, Department of Pharmacology, University of Chicago, digitoxin which contained radiocarbon was isolated from these plants. The University of Chicago group is utilizing the isolated radioactive drug in medical studies designed to give new information on the fate of this important heart stimulant in humans. Additional unextracted radioactive digitalis plants have also been made available through the Atomic Energy Commission to other medical groups for use in heart studies."

New clues to one of Nature's greatest mysteries, the process of photosynthesis, by which green plants manufacture sugars and starches, also are being uncovered with the aid of tagged carbon atoms. If scientists could duplicate the process, they might be able to create almost unlimited supplies of food and fuel.

Plants make sugars and starches from water and from carbon dioxide taken out of the air,

with the aid of sunlight. Radioactive carbon atoms added to the carbon dioxide are being traced all the way through the process of photosynthesis until they turn up in the plants' sugars. Several chemical compounds are formed in the process, some are produced by the plant in the amazingly short time of five seconds, and others make their appearance within 90 seconds.

Radioactive Insects Reveal Travels

Insects tagged with radioisotopes and then released can be easily identified among thousands of others caught later in traps. This is much easier than the old method of marking insects with colored dyes and is useful in learning how far and fast insects travel.

Flies, tagged by feeding them on radioactive phosphorus, were found to travel as far as 28 miles from the point where they were released in Oregon farm country. They flew about four miles in the first 24 hours. Traps set in barnyards caught several times as many of the tagged flies as those set in open fields. Flights of yellow-fever mosquitoes in Nigeria have been traced in the same way.

Such knowledge makes it easier to set up quarantine zones against harmful pests and to locate military camps or settlements beyond the reach of disease-bearing mosquitoes.

Radioactivity also helps prove that certain insects prey on others and thus can help in controlling pests. Entomologists had suspected that one type of mite was a parasite on cockroaches. They fed radiophosphorus to roaches, then found the mites also became radioactive, proving they fed upon their hosts.

Sterility a Weapon Against Flies

In most southern States, and at times in other parts of the country, cattle and other domestic and wild animals are attacked by the vicious screwworm fly. Females lay their eggs in open cuts or scratches; when the larvae hatch, they feed upon the animal's flesh, causing wounds that are often fatal if untreated. Department of Agriculture scientists have found that if male flies are made sterile by irradiating them with radiocobalt, and are then released to mate with females in the wild, the eggs which the females lay are sterile and do not hatch.

Small-scale experiments have shown that if large numbers of sterilized males are liberated, enough females will mate with them to reduce the next generation considerably.

Fruit flies have been fed radioactive iron, then sliced in thin sections which are placed against photographic film. Darkening of the film in various places shows what parts of the insect have taken up the iron. This same technique could help show whether insect poisons reach organs where they will be effective.

Movements of wireworms underground have been traced by feeding them material containing radiocobalt and then following their wanderings with a Geiger counter. An entomologist, tracking the subterranean paths of two radioactive worms in this way, found that they joined and continued as one. When he dug at the spot, he found only one worm—but it was twice as radioactive! One worm apparently had eaten the other.

In many different industries atomic energy, in the form of radioisotopes, is helping to make products faster, better, and cheaper. Edwin A. Wiggin, assistant to the director of the A.E.C. Isotopes Division, told me:

"In some cases," he said, "radioisotopes are doing things in factories that would be impossible by any other means.

"One widespread use is in making constant measurements of the thickness of Pliofilm,

paper, linoleum, plastics, rubber, tin, or steel manufactured in continuous sheets fed out from between rollers. If the sheet is too thin, the product may be spoiled; if too thick, the manufacturer may lose money. Previously, the only way to check thickness was to stop the machine and cut out a sample.

"But radioisotopes can gauge thickness continuously without the need of stopping production. Below the moving sheet is placed a source of radioactive material and above the sheet a detector. Increasing the thickness of the sheet decreases the radiation that gets through to register on the detector. Any variation shows up quickly, and adjustments can be made at once.

"Wear resistance of floor wax has been measured by mixing radioisotopes with the wax, then spreading it on linoleum. Comparing the amount of radioactivity before and after a certain amount of wear shows precisely how much wax has worn away.

"Wear of auto tires has been measured by incorporating in the tread a material containing radiophosphorus, then detecting with a Geiger counter the minute amounts of the tread worn off in short test runs. It also helps show the amount of wear on tires when a car is accelerated or suddenly braked, and the effects of various road surfaces.

Atom Works in Factories

"A food manufacturer used radioactive water to measure how far moisture penetrates rice grains in various lengths of time. The data helped develop a quick-cooking rice."

In many oil pipelines, Mr. Wiggin went on, gasoline, Diesel oil, or kerosene are run through one behind the other, then diverted to different tanks. It is difficult to tell just where one kind of oil ends and the type coming behind it begins. Usually, to avoid any possibility of mixing two kinds of oil, several hundred barrels are drained off when the interface nears the end of the line.

Now, however, the boundary can be marked by injecting a radioactive chemical into the last of one kind of oil as it runs into the line. A Geiger counter at the other end picks up the radiation and shows exactly when the interface comes along. Hence less oil needs to be thrown away (page 87).

In oil pipelines, too, scrapers sometimes are sent through with the flowing oil or under air pressure to clean off interior obstructions. If a scraper gets stuck, it is difficult to locate. Now scrapers are sometimes tagged with small pieces of radioactive cobalt. If one sticks, a



Radioisotopes Ride Harmlessly in a Plane's Wingtip

Heavy lead boxes normally used to shield radioactive materials in transit pose a serious weight problem in aircraft. But unguarded rays separated by the length of the wing offer no risk to passengers. This container is loaded at London. A long rod protects the handler.

Geiger counter passed along the outside of the line picks up the radiation from inside.

Measuring the height of molten metal in a foundry furnace is another job radiation can do accurately and easily, without being affected by heat or corrosion. A source of radiation is mounted on the outside of the furnace on one side and a counter on the other side, to pick up the radiation coming through. Both can be moved up and down. Few rays can penetrate the molten metal inside, but the counter shows a quick increase as soon as the instruments pass above its level.

Radioactive detectors also check whether containers of food or other materials are filled to the proper height. Packages on a production line pass between a radiation source

and a counter. If the contents are up to the right level, they block many rays from passing through; but if a package is not properly filled, more rays penetrate. This device can be rigged to flash a warning light or even to throw out a faulty package.

Oil field workers use radioactivity to help place acid in the right locations in deep wells to dissolve limestone that is blocking oil flow. They lower a Geiger counter to the depth of the limestone, then pour in acid mixed with radioactive material. Clicks from the counter, relayed to the surface, tell when the acid has risen in the well to the point where it is needed. Pressure then forces it into the rock.

Germes Test Soap

Radioactive bacteria have been used to test how well various soaps or detergents wash clothes. The bacteria are fed on radioactive material and then placed on swatches of cloth, each of which is washed with a different soap. Though any bacteria remaining on the washed cloths are invis-

ible, their radioactivity can be detected. The number remaining shows how well each piece has been cleaned.

To test how well sulphur insecticide sprays are retained on and in the leaves of plants, radioactive sulphur has been used in the sprays. A Geiger counter easily checks how much remains from time to time by counting the radioactivity.

Even golf balls have been made radioactive experimentally to see if they could be more easily located when lost in the rough. Unfortunately, a ball made "hot" enough to be detected from some distance away might be dangerous to the user unless he took special precautions.

Today's big question about peacetime

atomic energy is when it will be used for producing industrial power. One authority has predicted economical atomic power "in a very few years, certainly less than 10." Other estimates run up to 30 years.

Before this happens, costs must be greatly reduced and many technical problems solved.

In using atomic energy to make power, the fissioning of uranium atoms in an atomic reactor will merely provide a different way of creating heat, instead of burning coal or oil. The heat will be used to turn water into steam, which will run turbines that operate electric generators, just as is done today.

Chief advantage of atomic power is that the fissioning of all the atoms in one pound of uranium can produce as much heat energy as the burning of 2,600,000 pounds of coal. In practice, more than one pound of uranium will be needed, in order to have enough to start a chain reaction in the reactor. But no longer will it be necessary to transport vast tonnages of fuel to the power plants or provide large storage facilities.

Electric power produced by atomic energy cannot be much cheaper than present-day power, however. Fuel represents only about 20 percent of the cost of electric power to the consumer today. Even if atomic energy eventually proves to be cheaper than coal, the remainder of the process of making electricity will be the same as now, so that the other 80 percent of the cost will not be reduced.

Atomic power will not suddenly replace all coal, oil, and other fuels, but for many years will supplement them. Its first use probably will be in places where bulk fuel costs are high, but where transporting a few pounds of uranium or plutonium will be no problem.

The continually increasing demand for electric power will help bring about the use of



Atomic Tracers Distinguish a Pipeline's Different Oils

Pipe operators pump various grades of oil one behind the other. To determine where one ends and the next begins, they inject radioactive material in between. Here a technician listens for rays with a Geiger counter to tell the valve operator when to shut each grade into its tank (page 85).

atomic energy to produce it, some experts say. The electric generating capacity installed by utilities in the United States has doubled on the average in every decade for the last 40 years, and this is expected to continue.

This country is the world's second largest producer of uranium, with the Belgian Congo first and Canada a close third. Other large deposits also exist in Australia, Czechoslovakia, and Russia, and uranium is a by-product of South Africa's gold mines.

One authority estimates that deposits of uranium so far located might provide at least 15 times as much energy as known reserves of oil, gas, and usable coal.

Looking far into the future, some experts say atomic energy may help bridge the gap



A Geiger Counter Measures the Water Locked on Snowy Peaks

Irrigators and water-power producers need accurate forecasts of moisture to be released by spring thaws. Surveyors normally make tedious mountain climbs to weigh snow samples. Where they find access difficult, the radioactivity gauge can do the job for them. Capsules of radiocobalt planted in the ground bombard the snow. Its water content limits the number of rays that penetrate. This crossarm in the Sierra holds a Geiger counter whose telltale clicks are radioed automatically to headquarters. The man inspects the gauge.

between our supplies of coal and oil and the time when we learn to harness the inexhaustible power of the sun.

An amazing thing about one kind of atomic power reactor is that it can manufacture more fuel than it burns and produce useful energy at the same time. It is like burning coal in a furnace and finding more coal mixed with the ashes than was put in originally.

This is known as the "breeder" reactor, because it breeds or manufactures fuel while in operation. Uranium ore is a mixture of uranium 235 (with 143 neutrons and 92 protons

in its nucleus), which is fissionable, and uranium 238 (with 146 neutrons and 92 protons), which is not. The U238 is 140 times as abundant as the U235; in making atomic bombs, the U235 must be separated from the U238 by a costly and difficult process (page 74).

In a breeder reactor, however, both kinds of uranium can be used together. The breeder is loaded with a mixture of uranium 235 and 238. As the chain reaction gets under way, fissioning the atoms of uranium 235, some of the neutrons released are captured by the atoms of uranium 238. The captured neutrons

change the U238 into plutonium, a man-made element, which is fissionable like U235. This plutonium then enters into the chain reaction: its atoms are split by neutrons, releasing both energy and more neutrons. Some of these neutrons change still more uranium 238 into plutonium, which releases still more energy and neutrons; and so on.

The breeder reactor is the kind which probably will be used eventually in making electric power because it can utilize the abundant supplies of uranium 238 as well as the scarcer uranium 235. An experimental breeder reactor already has been operated in Idaho for more than two years, producing all the electricity needed to supply light and power for the building in which it is housed.

Actually, the breeding is not quite as simple as it sounds. The newly created plutonium fuel must be separated from U238 before it can be used to fuel another reactor, and a breeder may have to run several years before it yields as much new fuel as was put in originally.

Uranium to Power Atomic Submarine

The first practical use of atomic energy to manufacture power will be to drive the Navy's two new submarines, *Nautilus* and *Sea Wolf*.

The "firebox" of the *Nautilus*'s engine will be a reactor in which the fissioning of uranium atoms creates great quantities of heat. This type of reactor is much smaller than the big ones used in making radioisotopes and is of different design. Water, circulating through the reactor, will absorb the heat and carry it out to a boiler to heat more water and make steam. The steam will operate turbines, which will turn the propeller shafts.

Nautilus will be the world's first true submarine, a craft which can operate deeply submerged for months at a time if necessary, without ever having to come to the surface. This is possible because no oxygen is needed for the production of atomic energy.

A few pounds of uranium will run an atomic submarine for months without refueling. Her range of operation will be limited not by her fuel supply but only by the crew's endurance and the supplies of bottled oxygen, food, and weapons she can carry. In a recent test, 23 members of a crew stayed below battened hatches for two months in a submarine alongside the dock at Groton, Connecticut. They suffered no serious ill effects.

Running a submarine by atomic power has created special problems. Since the water that

circulates through the reactor and boiler will become radioactive, pipes, valves, and pumps must be absolutely tight, and strong enough to withstand even the shock of depth charges exploding near by. A leak of radioactive water would endanger the crews' lives. The reactor itself must be heavily shielded by thick concrete, lead, or some similar material, to protect the crew from deadly radiation.

Sea Wolf Will Use Liquid Metal

U. S. S. *Sea Wolf*, the second atomic submarine, will be powered by a slightly different type of reactor, using liquid sodium metal instead of water to carry heat from the reactor to the boiler.

To make *Nautilus*'s atomic submarine engine work successfully, scientists had to find a way to produce in quantity a metal which was little more than a laboratory curiosity only a few years ago. This is zirconium, long known but little used because it was difficult to produce in pure form.

Most metals, if used in construction of certain types of atomic reactors, absorb so many neutrons that the chain reaction is badly slowed down. But zirconium absorbs very few neutrons and is also highly resistant to corrosion. Under the lash of urgent necessity, scientists developed methods of producing pure zirconium at much lower costs and in large quantities. Five years ago the entire world supply could be set on an ordinary table. Today we are producing about 300,000 pounds a year.

Driving airplanes with atomic power is being studied, but is a far more difficult problem. Such planes would use nuclear energy simply as another way of supplying heat, instead of burning gasoline or jet fuel.*

For propeller-driven aircraft, the atomic heat would be used to make steam or hot air for driving turbines, which would turn the "props." In atomic-powered jet planes, small reactors probably would heat the air that is compressed and released in the jets.

Chief difficulty in designing atomic-powered planes is that the intense radioactivity from the engines would be highly dangerous to the crew unless they were protected by some very dense shielding material, such as concrete or lead. The weight would be a serious handicap in a plane. Ground crews, too, would be

* See, in the NATIONAL GEOGRAPHIC MAGAZINE: "Fact Finding for Tomorrow's Planes," by Hugh L. Dryden, December, 1953, and "Flying in the 'Blowtorch' Era," by Frederick G. Voshburgh, September, 1950.



Even a Dog's Life Can Be Made Happier Through Atomic Energy's Healing Power

Radiotherapy often clears up nonmalignant eye tumors in humans as well as in animals. Here an applicator tipped with radioactive strontium treats an inflammatory tumor in Washington, D. C. A transparent plastic shield protects the veterinarian's hand from overexposure through frequent use.

endangered by the radioactivity when the plane landed. One researcher told me, however, "We feel sure that we can solve the shielding problem."

The first planes to use atomic power probably would be military aircraft, whose operations today are limited by the fuel they can carry. Fission of one pound of uranium theoretically would supply as much heat as 1,700,000 pounds of gasoline. A few pounds of uranium would provide power for a plane almost indefinitely.

For the same reason, atomic power also would be of great usefulness in many non-military functions of aircraft. Planes carrying on weather reconnaissance, searching for persons lost at sea, or mapping and patrolling inaccessible or uninhabited areas would be

able to perform far more efficiently if they did not have to return to base for refueling at frequent intervals.

Atoms Won't Tilt Islands

For all its wonders, atomic energy cannot do everything, despite what some people seem to believe. Somehow a story got started that atomic scientists at Brookhaven National Laboratory were going to change Long Island's climate by tilting it so that one end would be higher, and therefore cooler, and the other end lower, and hence warmer.

A man telephoned the laboratory and said, "I just heard about your plan to tilt Long Island to change the climate. I own a lot of real estate there; confidentially, would you tell me which way you're going to tilt it?"

Every Year Since 1877, Canine Aristocrats Have Won Honors—and Even Once a Pearl-handled Revolver—in the Nation's Premier Dog Show

By JOHN W. CROSS, JR.

Chairman, Dog Show Committee, Westminster Kennel Club

OF THE 22,500,000 dogs estimated to make up the canine population of the United States, about one in ten thousand sees the inside of New York City's Madison Square Garden in any one year. Those that do are the elite of their kind, there to be exhibited at the annual Westminster Kennel Club Dog Show in February.

Westminster is the world series of dogdom, and 1954 marks its 78th consecutive year—a record approached by no other dog show in the world. England held its first one 18 years earlier—in 1859—but interruptions caused by wars have prevented any challenge to Westminster's record of consecutive shows.

In fact, the only sporting events in this country with a record so long and unbroken are the Kentucky Derby, first run in 1875, and two other Churchill Downs races dating from the same year. In the early years, however, even the Derby had not yet achieved its present national prominence. Westminster, on the other hand, has always been queen of American dog shows, and through all the years a win there has been prized above all others.

Most Dogs Enjoy a Show

Although many people seem to imagine that dogs don't like dog shows, the fact is that the great majority of them enjoy nothing more. To them the traveling crate and station wagon that bring them to the Garden are what the clanging bell was to the fire horse in days gone by. They act as if the whole affair is being put on in their honor and for their personal delight.

When their showing days are over and they are left behind as the younger dogs go off to shows, veterans of bench and ring are as disconsolate as politicians put out to pasture by the electorate. Many a kindhearted owner has taken an old dog to a show, entering him "For Exhibition Only," just so that he could once again savor the life he has learned to love.

The average spectator, looking at and listening to a row of yapping terriers on a bench, decides that they must be expressing their distaste for the proceedings. This is because he attributes to dogs his own reactions. Mr. and

Mrs. Public would not like to be chained to a bench with all that noise around them; therefore the dogs can't possibly like it!

The fact that human beings willingly go to noisy parties, conventions, and political rallies is conveniently forgotten. What would dogs have to say about these if they could talk?

Another popular misconception is that show dogs can't be house dogs and that the reverse is also true. Actually there are many show dogs—some of the very best—that are house dogs all their lives.

The house dog's intimate association with people seems to help bring to full flower the responsiveness so important in the ring. An alert dog, eager to please, will show to advantage in front of the judge. The winner of Best in Show at Westminster in 1952 and 1953, a Doberman Pinscher named Rancho Dobe's Storm, was raised in a New York City apartment and has been a house dog since early puppyhood (page 114).

The popularity of certain breeds changes, as do women's fashions, and sometimes for equally inexplicable reasons. One well-known factor in the rise of the smaller breeds, however, has been the enormous increase in the dog population in our large cities.

Apartment-sized Breeds Popular

Although you will find Great Danes and St. Bernards living in small apartments with their owners, these cases are exceptional, and certainly one of the reasons for today's enormous registration of Cocker Spaniels is that the Cocker is an "apartment-sized dog." Other factors, of course, enter into this, such as his soulful eyes and his generally merry disposition (page 93).

Among the most popular of city dogs are the terriers. These little dynamos seem to enjoy the fast pace of modern city life, and they relish the company of human beings no less than their encounters with other dogs when being walked.

While many terriers enjoy the canine counterpart of a bout of fistcuffs, there is little doubt that the leash and collar which restrain the city dog add to his apparent belligerence.

Should the owners let both dogs loose, it is quite possible that a joyful romp rather than a dogfight would result, but the danger from traffic makes this test impossible in most cases.

There is a widespread tendency to make sweeping statements about certain breeds, based upon experience with an individual representative. As in most generalities, innumerable contradictions can usually be found. Experienced dog people have learned, the hard way, to protect their statements with such words as "most," "many," and so on.

One may say, for instance, that in most of the terrier breeds the majority of dogs are what people refer to as high strung, and that they like to be heard as well as seen. But if you recommend a Fox Terrier to your non-doggy friend as a peppy animal, he will invariably acquire a puppy that turns out to be a regular lazy bones, rousing himself only for the pleasant task of eating and then returning to sleep.

Dogs as individuals differ as greatly as do human beings. Thousands of dogs have the same unreasoning and uncontrollable fear of thunder that your Aunt Matilda or your Cousin Jim has. More than one owner afflicted with this animal reaction rides out each thunderstorm in a dark closet, clutching his dog, both of them trembling as if upon the edge of doom.

There are dogs that plainly prefer the company of men to women and vice versa. This is simply because they have been raised entirely by one or the other sex, but it is often a blow to the person who cheerfully says, "All dogs like me."

This Time People Did the Tricks

Dogs' reactions varied widely when the National Geographic Society last year sent a team of four staff photographers—Kathleen Revis, Willard R. Culver, Robert F. Sisson, and David S. Boyer—to make the appealing color pictures that illustrate this article. They worked under the personal direction of the late Franklin L. Fisher, Illustrations Editor, whose keen interest in dogs has been reflected in many memorable articles in the NATIONAL GEOGRAPHIC MAGAZINE.

Bulldogs never dropped their masks of monumental dignity (page 107). St. Bernards exemplified their breed's placidity (page 96). Keeshonden were sweetly obedient to their small mistress's commands (page 98), while Samoyeds were as gentle as they looked (page

107). But some of the others proved a problem. Said Miss Revis afterward:

"As we walked along in front of the benches, we spotted dogs just begging for their pictures to be taken. By the time we set up the lights and focused the camera, the pose was gone. We had to recreate it."

"That's when we started clowning," said Mr. Sisson. "We mewed like cats, chirped like birds, banged tin pans, danced—anything to get the dog's attention."

At the end of the two-day event all four were dog-tired, but they had a notable gallery of canine character studies.

Even Dogs Must Get an Education

Day by day a dog's life is not very different from that of his owner; most of the days are routine and uneventful. There are a few gold-starred ones—the day the steak was dropped on the kitchen floor and he was quick enough to grab it and run! the first day of the hunting season. But always there is the matter of an education; dogs have to go through it, just as human beings do.

A show dog learns two basic lessons: To stand and hold a position so that he may be displayed to the best advantage in front of the judge, and to trot in a straight line beside his handler so the quality of his gait and movement may be observed. This is part of what is meant when it is said that a dog "shows well," and the closer the competition the more important this factor becomes.

In the training of dogs the two dominant factors are the desire to please the master and the love of food. Fear used as a means of training is neither successful nor intelligent and is used only by those who lack patience and understanding of a dog's basic make-up. He will appreciate a tidbit now and then, but he will never perform as consistently and as joyfully as he will in return for a pat on the head or a word of praise.

Numerous well-trained animals have apparently been taught to understand words. Actually, of course, the word itself is totally lacking in importance. If the dog is taught to bring your slippers, he will always bring your slippers if you say, "Bring in the kitchen stove," provided that you have always used "kitchen stove" when referring to slippers. He brings them because he has learned that it pleases you, and that is his dominating desire in life.

While much of a dog's behavior and many
(Text continued on page 109)

A Collie Escorts His Daughter at the Westminster Dog Show

For centuries the Rough-coated Collie herded sheep in Scottish Highlands. To traverse narrow sheep paths, he became agile and strong; to brave cutting winds, he grew an abundant, heavy coat.

When Queen Victoria visited Balmoral Castle in the mid-19th century, she fell in love with this intelligent friend of her people and spread his praises. In World War I the Collie faced battle-field fire to find Allied wounded for medical corpsmen.

Darwood Dark Princess (standing) and Champion Dorwood Dreamy at Glencoe, Illinois, display the long, aristocratic nose and elegant ruff of the show Collie.

♣ Snd-eyed Cocker Is the U. S. Favorite

The Cocker is one of the smallest members of the large spaniel family, which made its recorded debut in 1586. It was already popular by Queen Elizabeth's time, when Dr. John Caius wrote: "These dogues are lile, pretty, proper and fyne, and sought for to satisfy the delicatenesse of daintie dames." Today the Cocker's popularity stems from the fact that it is an apartment-size pet as well as a first-class bird dog.

Floppy-eared Cavalier Challenge is owned by Capt. P. C. Doran of Washington, D. C.

© National Geographic Society

Collages by Sylvia Gerschlager Photographs
and E. Pincus-Coffi and Kathleen Beck





TERRIERS

JUDGE	TIME	DOGS	BITCHES
1st 2nd 3rd 4th 5th 6th 7th 8th 9th 10th 11th 12th 13th 14th 15th 16th 17th 18th 19th 20th 21st 22nd 23rd 24th 25th 26th 27th 28th 29th 30th 31st 32nd 33rd 34th 35th 36th 37th 38th 39th 40th 41st 42nd 43rd 44th 45th 46th 47th 48th 49th 50th 51st 52nd 53rd 54th 55th 56th 57th 58th 59th 60th 61st 62nd 63rd 64th 65th 66th 67th 68th 69th 70th 71st 72nd 73rd 74th 75th 76th 77th 78th 79th 80th 81st 82nd 83rd 84th 85th 86th 87th 88th 89th 90th 91st 92nd 93rd 94th 95th 96th 97th 98th 99th 100th	1st 2nd 3rd 4th 5th 6th 7th 8th 9th 10th 11th 12th 13th 14th 15th 16th 17th 18th 19th 20th 21st 22nd 23rd 24th 25th 26th 27th 28th 29th 30th 31st 32nd 33rd 34th 35th 36th 37th 38th 39th 40th 41st 42nd 43rd 44th 45th 46th 47th 48th 49th 50th 51st 52nd 53rd 54th 55th 56th 57th 58th 59th 60th 61st 62nd 63rd 64th 65th 66th 67th 68th 69th 70th 71st 72nd 73rd 74th 75th 76th 77th 78th 79th 80th 81st 82nd 83rd 84th 85th 86th 87th 88th 89th 90th 91st 92nd 93rd 94th 95th 96th 97th 98th 99th 100th	1st 2nd 3rd 4th 5th 6th 7th 8th 9th 10th 11th 12th 13th 14th 15th 16th 17th 18th 19th 20th 21st 22nd 23rd 24th 25th 26th 27th 28th 29th 30th 31st 32nd 33rd 34th 35th 36th 37th 38th 39th 40th 41st 42nd 43rd 44th 45th 46th 47th 48th 49th 50th 51st 52nd 53rd 54th 55th 56th 57th 58th 59th 60th 61st 62nd 63rd 64th 65th 66th 67th 68th 69th 70th 71st 72nd 73rd 74th 75th 76th 77th 78th 79th 80th 81st 82nd 83rd 84th 85th 86th 87th 88th 89th 90th 91st 92nd 93rd 94th 95th 96th 97th 98th 99th 100th	1st 2nd 3rd 4th 5th 6th 7th 8th 9th 10th 11th 12th 13th 14th 15th 16th 17th 18th 19th 20th 21st 22nd 23rd 24th 25th 26th 27th 28th 29th 30th 31st 32nd 33rd 34th 35th 36th 37th 38th 39th 40th 41st 42nd 43rd 44th 45th 46th 47th 48th 49th 50th 51st 52nd 53rd 54th 55th 56th 57th 58th 59th 60th 61st 62nd 63rd 64th 65th 66th 67th 68th 69th 70th 71st 72nd 73rd 74th 75th 76th 77th 78th 79th 80th 81st 82nd 83rd 84th 85th 86th 87th 88th 89th 90th 91st 92nd 93rd 94th 95th 96th 97th 98th 99th 100th

★ "Stay and Show!" the Handlers Command. Sealyham Terriers Obey

A century ago rats, polecats, and badgers plagued a Welsh estate called Sealyham. Its owner, Capt. John Edwards, bred and set against the invaders a stocky little dog of pluck and determination. Recognized as a breed in 1911, the **Sealyham Terrier** presents a stylish appearance with trim wire-haired coat, short legs, bushy beard, and exclamation-point tail. These await judging in the Westminster Dog Show ring. "The fancy," as dog fanciers are officially known, surround them.

→ **Lady Twinkle**, an **Old English Sheepdog**, nestles close to her master, **Peter Bruno**. The dog's eyes, one blue and one brown, stare into a shaggy curtain of white hair. Keen hearing and small compass for the visual handicap. Lady Twinkle's ancestors herded sheep and cattle; she corrals ribbons.

✦ **Champion Star Twilight of Chis-Mur**, a **Yorkshire Terrier**, took Westminster's best-of-breed honor. At home the dog wears his trousers in was-paper curlers to prevent their matting. Here Mrs. Joan Gordon dresses his silky coat with water from an atomizer. Her four Yorkshire won these ribbons.

© Reproductions by National Geographic Photographers Wyland W. Colver and David H. Borer





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Champion Bertino de la Colina Dozes on the Bench

In 1949 an airliner crashed in the Swiss Alps. St. Bernards were first to reach survivors. The breed is credited with saving some 2,500 lives in Alpine rescues.



Contributors to National Geographic Photographs: Robert F. Heath

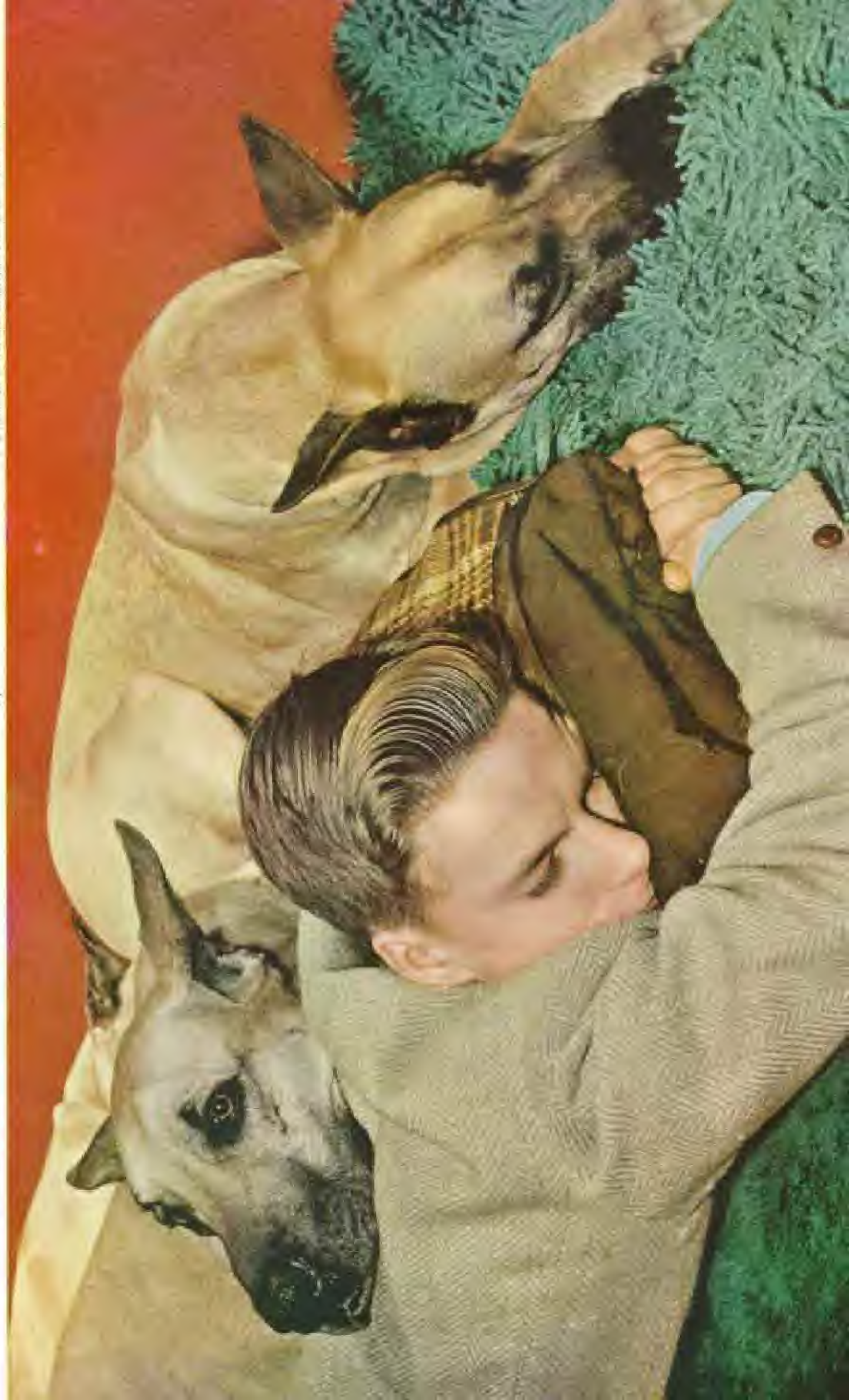
Boston Terrier Prepares Dinner with Bag-ripping Teeth

White collar and shirt make Champion Lewana's Black Velvet a proper Bostonian. As American as baked beans, Boston Terrier was bred for city living.

Champion Foray's Fancy, a Great Dane, Keeps Watch over Sleeping Companions. German Nobles Used the Breed as Bodyguards

97

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58

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Wolf-gray Keeshonden Press Close to Their Mistress, Drina Rutkay. Their Ancestors Worked as Dutch Barge Guards

Champion Blakeen Balli Ha'i, a Mobile Powder Puff, Won Top Honors →

The Poodle's haircut, which inspired a recent culture for women, was designed during his career as a retriever. The cut protected joints from cold water while lightening the weight of hair. Haralied by Robert Gorman, Balli Ha'i last year was judged best in Westminster's non-sporting group.

↓ Called the "vest-pocket hunting dog," the **Brittany Spaniel** hails from France. Helgramite Wukie and her benchmate, Helgramite Diao de Beauch, share a picnic lunch.

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100

Illustrations by National Geographic Photographers David H. Bagge (top) and William B. Carter

↑ **Emperor Shen Sung Squints
at the World from Almond Eyes**

The **Chow Chow's** rich red coat, blue-black tongue, lionine mane and paws, and plumelike tail are accompanied by an apparent scowl that warns off strangers. In China, his homeland, he has been a hunter, guard, pet, and popular substitute for roast mutton.

↓ **Warm-eyed Shetland Sheepdogs
Are Collies in Miniature**

About 1900 the fancy discovered on the Shetland Islands a sturdy, intelligent sheepdog affectionately known as the Sheltie. Progressive breeding has produced such **Shetland Sheepdog** beauties as Champion Ardencaple's Cute Trick (left) and Nethercrest Smile Awhile.





♣ **Chihuahuas, the Tiniest Dogs, Face Their Judge, Mrs. Justin Herold**

The Aztecs believed Chihuahuas piloted the human soul through the underworld. With the passing of Montezuma the breed was lost, only to be found 100 years ago in Mexico.

♣ Gross' La Duquesa De Maron weighs 3½ pounds.

♣ **Hamilton Pehma Once Trained the Dalai Lama in His Palace**

House guard to Tibetan aristocracy for nearly 800 years, the Lhasa Apso is rarely sentimental about man. Champion Pehma, one of a few hundred "lion dogs" outside Tibet, came to America as a gift from the Dalai Lama to explorer C. Seydun Cutting.





Rangy Whippets, Bred as Racers, Have Become Fashion's Pets. These Four Belong to Mrs. Colin A. Studds of Virginia Beach

Pals: Yorkshire Terrier and Irish Wolfhound

Fair Fingal of Ambleside, believed the tallest purebred dog in the United States, stands better than 37 inches. **Irish Wolfhound's** ancestors fought in clan wars, hunted wolves and giant elk. Fingal fails to impress **Kylebro Poppet**.



Student: Lake Como's Donald Jay

The **Chesapeake Bay Retriever** with **Max J. P. Wiley** is one of a breed developed in Maryland to retrieve ducks from tidal flats. Powerful swimmers, Chesapeakes have webbed feet and waterproof coats.

© Reproductions by National Geographic Photographers Robert P. Adams (left) and Geoffrey Hoels





Photographs by National Geographic Photographers Robert F. Brown

↑ The Audience Quiets Down; Collies Enter the Stage

Dogs are big business in America. Their masters spend half a billion dollars a year on such items as prepared food, beauty parlors, licenses, collars, blankets, baskets, toys, medicines, veterinarians, funerals, and shows such as the Westminster, held annually in Madison Square Garden, New York. Some 40 percent of the families in the United States own dogs, but few enter them in shows.

More Collies are used on American farms than any other herding breed.

← An English Setter Points to Quail Caged Amid the Corn

In 1953 the Westminster Kennel Club brought to live quail for its field trials. Sportsmen say that pointing dogs have a hypnotic effect on the birds, which stay in cover as long as the dog stands at rigid attention.

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Afghan Hounds Were Portrayed on Egyptian Tombs 5,000 Years Ago

High, powerful hindquarters make Afghan Hounds champion handlers. Developed on the Sinal Peninsula, the breed became established in Afghanistan, whence it was introduced into England. Centuries have changed the dog's appearance only slightly. Right: Two Afghans await the judging.

4 Champion Kurki Ban Ghazi, shown with his owner, Mrs. Ruth H. Thom, Southport, Connecticut, is one of the finer top-winning Afghans in the United States.

105

© Reproductions by National Geographic Photographers Richard H. Cohen (left) and David A. Turner



Miniature Schnauzers' Sport Bushy Beards

The American Kennel Club, social register for purebred dogs in the United States, recognizes 111 separate breeds. They fall into six major groups: sporting dogs, hounds, working dogs, non-sporting dogs, toys, and terriers. In this series Cocker Spaniel, Brittany Spaniel, Chesapeake Bay Retriever, English Springer Spaniel, and English Setter represent the sporting group. Hounds include Afghan, Whippet, and Irish Wolfhound. Collie, Shetland Sheepdog, Old English Sheepdog, Great Dane, St. Bernard, Boxer, Samoyed, and Doberman Pinscher count among working dogs. Poodle, Chow Chow, Bulldog, Boston Terrier, and Kingdome fall in the non-sporting group.

Chihuahua and Yorkshire represent the toys. Terriers include Skyeham, Irish, Airedale, and Miniature Schnauzer. Through the centuries the big cursing hounds were reserved largely for the wealthy, but the common people had their own dogs, the lively little terriers. Named after the Latin word for earth, *terro*, these burrowing dogs helped their masters keep down rats and other vermin.

Miniature Schnauzers were developed in Germany. Though they preserve an instinct for rat-fighting, these four serve primarily as pets. Champion Gay Knight, Lovely Lady, Gentleman Jack, and Champion Lucky Lady came from Phil-Mar Kennels.

© National German-Speaking Society

PHIL-MAR
KENNELS REG.
ELIZAVILLE, N. Y.



Siberia's Samoyeds Helped Conquer the Arctic

Famed as sled dogs, **Samoyeds** pulled explorer Nansen "farthest north" in 1895. Mikha's Arctic Samoyed and Polar Princess III of Lunken show the breed's handsome snowy coat and smiling face. Samoyeds have no doggy odor.



Bulldog's Sour Look Veils a Sunny Disposition

To equip the **Bulldog** for bulldozing in the 17th century, English breeders pulled his lower jaw out, pushed his nose back. Doc's Miller and Filbertsger's Amberters are proof only when demanding the best seats for TV.

107

© Reproductions by National Geographic Photographers Capt. G. Hunt, Capt. J. Hunt, and Capt. J. Hunt





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108

Illustrations by National Geographic Photographers Wilfred H. Oulton and David H. Everett (London)

✦ Masked Boxers Served in Two World Wars

After long use in dog fighting and bullbaiting, the Boxer became one of the breeds selected for police training in Germany. Barbara Stewart makes a pencil portrait of Bambi's Duchess of Earle.

✦ Pequa Don Eats His Wiener's Reward

Donnie, an English Springer Spaniel, watches over children at home and serves his master as a gun dog. To Patty Matson, a member of his family, he is a hero for having saved her brother from drowning.



of his reactions are similar to a child's, he has certain habits that people cannot understand. Usually this is so because we forget what the life of dogs was like in their wild state and because they have become so closely attached to man that we interpret their reactions and behavior in the light of our own.

Ways Inherited from the Wild

Have you ever taken your dog for a walk on the beach and had him walk up to a well-decayed fish tossed up by the waves? He will smell it delightedly and then hurl himself upon it with glee, rubbing himself into the odoriferous remains.

We are appalled by such behavior. Human beings don't do it, so why should a dog? Countless generations of dogs have done it, and for a very good reason, although that reason no longer exists. The theory is that their forebears did it in order that the strong smell thus acquired would overpower their own scent and make it possible for them to hunt without having their prey warned of their approach by a shift in the wind.

A far less unpleasant habit, but one that also stems from days gone by, is the burying of bones. In his wild state the dog often killed more than he could consume at one time and buried the leftovers so that he might return to finish them.

Another peculiar habit of many dogs—that of circling three or four times before lying down—is believed to be carried over from the wild animal's habit of trampling down the grass to make his bed.

A frightened dog, we all know, tucks his tail between his legs. But why? The wild dog was a hunter, but he was also hunted—and the explanation may be that if his tail was between his legs it could not be grabbed in a pursuer's mouth.

Thus, many of the dog's actions today can be easily understood if we recall what his life in the wild state was like. Far less easy to understand are some of the remarkable and well-authenticated cases of dogs with apparently supernormal perception.

We know that dogs have powers of hearing far superior to our own; they can pick out the sound of a beloved footstep from among a hundred strange ones. Many of us have known dogs that could tell the sound of the motor of the family car from that of others of the same make. These are striking but understandable demonstrations of their powers of hearing.

But how do we explain the ability of a dog in a city apartment to tell beforehand that the elevator will stop at his floor and, beyond that, to tell whether the passenger is someone he likes and goes to greet silently with wagging tail or someone at whom he barks before the elevator has even stopped? Yet I knew such a dog and saw him demonstrate these remarkable powers dozens of times.

We accept the fact that homing pigeons return from wherever they may be released, although we do not understand how they do it.* We have all heard of dogs that have returned from great distances, but did you know that there is a completely authenticated case of a dog that was left behind in Idaho and then set out and found his master at a place near Oakland, California, to which he had moved? Could you do as much?

How can a dog have foreknowledge of a human death? Yet I knew a dog that did. At the instant that his master, who was upstairs, suffered a heart attack this dog bolted *through* the screen door onto the lawn. There he howled for three-quarters of an hour—until the moment of his master's death. Then he stopped.

In another case, fully authenticated, a strange dog appeared in front of a house in which the owner lay dying. The dog wailed dismally, and although driven away repeatedly he kept returning. After the man's death he left and was never seen there again.

So when an owner tells you strange stories about what his dog has done, hesitate before you lay it all to a too-lively imagination.

Why Show Dogs Have Long Names

Every year Westminster is visited by ladies and gentlemen of the press who never go to any other dog show. Their reporting has a strong tendency toward the humorous approach. The perennial favorite of the cartoonist is the lady of the dreadnaught class with a leash on the microscopic Chihuahua to which she belongs.

At least one columnist can be counted on annually to dig into the dogs' names listed in the catalogue and come up with a word picture of a fond owner calling to his dog:

"Here, Ch. Hailstone Golden Enchantment! Here, Ch. Hailstone Golden Enchantment!"

That the picture drawn is good for a hearty laugh, no one would deny. That it is far from reality could also hardly be denied, even by

* See "The Flying Telegraph," by Joseph F. Spence, in the NATIONAL GEOGRAPHIC MAGAZINE, April, 1947.

the ladies and gentlemen who suggest the picture for our entertainment.

At first glance, the only information to be gleaned from the purely imaginary name Ch. Hailstone Golden Enchantment would probably be that the dog is a champion (a title retained for life) and that its color is somewhat akin to gold, although this is not certain. The dog might be a Great Dane, a Boxer, a Golden Retriever, or a dog of any other breed that produces varying shades of yellow, fawn, or red.

To the fancier, however, the name would mean that the dog was bred at the Hailstone Kennels of Mr. and Mrs. Richard Roe in Erehwon, New Jersey. Hailstone is known to breed only Golden Retrievers, so that is the dog's breed. It was probably sired by Ch. Hailstone Golden King and its dam was probably Ch. Hailstone Enchanting Girl.

In this case the name gives no clue to the sex of the animal, and this is not unusual in the naming of other animals besides dogs. The fabulous race horse Native Dancer is still believed by thousands of people to be a mare because to them the name sounds feminine. This famous horse's name, incidentally, illustrates the turf's method of paying tribute to ancestry—his sire was Polynesian and his dam was Geisha Girl.

Short "Call Names" for Everyday Use

People often ask why dogs cannot be given a single name, such as Polynesian. The answer lies in simple mathematics. Approximately 9,000 thoroughbred horses are registered in one year in the Jockey Club Stud Book, but about 300,000 purebred dogs are registered annually in the Stud Book of the American Kennel Club.

Add to this the fact that thousands of dogs live to be more than ten years of age and that many authenticated cases of more than twenty years of age exist, and the reason for kennel names becomes clear. There are simply not enough single names to go around.

Kennel names are owned, for a fee, and no one may use them but the proper owner. You may register your dog as Hailstone Rover and there will be no other dog with that name—although there may be a Rainstorm Rover and a Snowflake Rover. For breeding purposes each dog must have a name which prevents the possibility of confusion with another individual.

How does the owner call his dog with the fancy name? He probably says "Here, Spike!" or "Here, Molly!" Show dogs are usually



given a "call name" which is wholly different from their registered name. This is done for the dog's protection at shows, where spectators walk down the aisles of benching, catalogue in hand. If a dog responded to every reading of his name from the catalogue he would soon be exhausted trying to find a friend among all the strangers addressing him.

Prizes Once Included a Gold Necklace

A search through old Westminster catalogues will show, not too surprisingly, that things were quite different 75 years ago. In one class for English Setters there were four Rovers and three Toms, all with a notation that their breeding was unknown. In those days, of course, animal breeding was apt to be pretty haphazard, but a stud book—like anything else—has to have a beginning.

Once there existed a variety of classes which would be a nightmare in today's swiftly paced competition. In 1880, for instance, there was



Fanciers Throng Madison Square Garden for the Nation's Biggest Indoor Dog Show.

Owners and handlers reach their dogs into a show stance at Westminster's 77th annual show breed competition. Judges inspect and take notes. From the Doberman Pinscher ring (foreground) came the Best in Show winner, Champion Rancher Dodge's Storm (page 114). English Setters stand in next dog

a class for "Red Setters" of either sex, to be exhibited by ladies only, and the prize, which the judge placed upon the winning lady right in the ring, was a gold necklace.

Today a sterling silver medal is given for Best of Breed and sterling silver bowls for group winners and Best in Show. Cash prizes reward owners of winning contestants.

Contrast these simple trophies with two of the prizes at Westminster's first show: a "Gold and Silver Mounted Pearl Handled Revolver" and a "Russian Leather Silver Mounted Fly Book and One Gross Assorted Flies."

In the early days it was quite common to take a dog to a show with the idea of selling it, and the asking price was listed in the catalogue right after the dog's name, something which is no longer permitted.

At the very first Westminster, in 1877, its benches were graced not only by royal dogs but by dogs of royalty. A Londoner, T. Medley, Esq., exhibited two Deerhounds, Oscar and Dagmar, bred by "Her Majesty the Queen of England from the late Prince Consort's famous breed," and you could purchase either of them for 550,000.

The royal touch appeared again in 1889 when a Mr. Edward Kelly of New York entered a Siberian Wolfhound by the name of Ivan Romanoff. The fact that the breeder of this hound was the Tsar of Russia probably accounted for the \$10,000 price tag, but a prospective purchaser might have had reservations about the Tsar's breeding operations when he read in the catalogue that Ivan was listed as "Pedigree Unknown."



World World

Best Team in Show: Shetland Sheepdogs with Snowy Vests

These blue merle Shelties, shown by Elizabeth D. Whelen, of Kimberlin, Pennsylvania, are team winners because they match in color, height, weight, and conformation. By no means toys, they retain the breed's working potential.

The following year Ivan was back, but he had a rival, most appropriately named "Rival," bred by the Emperor of Germany and duly possessed of a pedigree. The price for royal Wolfhounds held steady, for Rival also could be yours for a mere \$10,000.

Apparently, however, the most valuable of all dogs entered in those days was a "white and lemon, two-and-a-half-year-old imported Maltese Terrier" by the name of Mozart. He was owned by Miss Eva P. Russell, of New York City. In the place in the catalogue where the sale price of a dog was usually listed, Miss Russell put just one word—"Priceless."

From its first show Westminster has always had a "Miscellaneous" class. Today its entries are confined to dogs of breeds recognized in foreign countries but not yet sufficiently

represented in this country to be given official recognition. If you have a Rhodesian Ridgeback, a Vixen, or a Russian Owtchar, you may enter it in the miscellaneous class.

In the early shows, however, you could enter anything that resembled a dog. Not even the normal complement of four legs was a requisite, for in the very first show, Nellie, "a brown, two-year-old bitch," was entered in this class although she had been born with only two legs.

In 1880 a two-year-old Australian wild dog, or dingo, was entered, presumably having received a day off from the zoo, for his owner was listed as Mr. W. A. Conklin, whose address was given as the Central Park Menagerie.

If you had wished to own a dog whose career it would be impossible to duplicate, you could have acquired Nero, a cross between a Siberian Bloodhound and a St. Bernard, who was

"in charge of the first baby elephant that was ever exhibited in America." His owner, Mr. James McLaughlin, was willing to part with Nero for \$250.

Pointer "Sensation" Is Club's Symbol

As the years went by, however, fewer and fewer of those crossbreeds and freaks appeared. In their places could be found the first representatives of many of the breeds which today are most popular in this country. The Pekingese, the Chow Chow, the Saluki, the Kerry Blue Terrier, and even the Boxer, whose rise to eminence has been almost unbelievably rapid, made their first public appearances at the humble level of "Miscellaneous." Who can tell what breed will next rise from this stepchild classification to rival some of the popu-

lar breeds which may today be on their way down?

In the early days of Westminster, field dogs dominated the show. Pointers and setters accounted for more than half the entries.

The club had been founded by a group of sportsmen who were primarily interested in bird dogs and their work in the field. For many years the club had kennels at Babylon, Long Island, where members raised and trained their own pointers, mostly from stock imported from England. One of its first and greatest importations lives on today as the club's symbol—the immortal Sensation, on point with his left forefoot raised.

111 Breeds Recognized Today

As time passed and interest in purebred dogs of all breeds increased, this dominance of the field dogs ceased. At the turn of the century, for example, there was great interest in St. Bernards, and one class at Westminster had 53 of these great dogs entered. What a sight that must have been! Today no ring in the show would be large enough to hold them all.

Collies, too, were great favorites at this time, and the rivalry between the kennels of the elder J. Pierpont Morgan and Samuel Untermyer was fierce. Although fashions in dogs change greatly over the years, Collies still have one of the largest representations at Westminster, usually a hundred or more (pages 93 and 104).

Today there are 111 breeds recognized by the American Kennel Club, and classes for all of them are provided at Westminster. These breeds are divided into six groups: sporting dogs, hounds, working dogs, nonsporting dogs, toys, and terriers (page 106).*

You will usually find one hundred or more of these breeds on the bench at the Westminster show, a greater variety than you are likely to see anywhere else in your life at one time.

How Dogs Are Judged

On the arena floor of Madison Square Garden, where the circus, the rodeo, and hockey, basketball, boxing, and other athletic events take their turns, are set up the judging rings for the dog show. Sports writers have been known to refer to a boxing ring as the "squared circle"; at Westminster the judging rings are "rectangular circles," and there are 12 of them. There are aisles all around, and those spectators not fortunate enough to find seats stand to watch the judging.

Competition at a dog show is, to put it simply, an elimination contest. A dog is usually entered in one class in his breed. If he wins his class he competes against the winners of the other dog (male) classes for his breed. The best of these is known as Winner, Dog, and a reserve is also selected. The winner is next judged against his counterpart, Winner, Bitch, for Best of Winners.

Finally, Best of Breed is to be judged, and champions of both sexes, plus the Best of Winners, come into the ring. If Best of Breed is awarded to a dog, then a somewhat anticlimactic award of Best of Opposite Sex is given to the best bitch, or vice versa. This latter award has been described by certain acid exhibitors as Best of Losers.

There are two more steps in the contest. The first is known as group judging, in which the Best of Breed winners in each of the six groups compete against each other. Finally the six group winners compete for that most coveted award, Best in Show.

Laughter Often Leavens the Show

Few events take place in this world without offering an opportunity for laughter, and a dog show is no exception. Probably Westminster's all-time record for levity was set in 1937 when the Masters of Foxhounds held their show at Madison Square Garden in conjunction with Westminster.

On the final night, before a capacity crowd, judging for the best pack of hounds took place. Each pack in turn was brought to the center for evaluation by the judges and then returned to its location at the edge of the ring.

When the pack of American Foxhounds returned, however, one lone male remained in the center—his leg raised high in a familiar position. He posed motionless for a seeming eternity as the crowd roared with laughter and encouragement. The gesture was an empty one, if the expression may be used, and at last the hound lowered his leg and returned to the obscurity of the individual in the pack.

Although Westminster runs for only two days, a full year of work goes into the making of the show. The club's Dog Show Committee starts its preparations with the selection of its judges. Some fifty experienced men and women are chosen to officiate—probably one or two judges from England, a couple from

* For authoritative articles in the NATIONAL GEOGRAPHIC MAGAZINE on dogs of all six groups, illustrated with paintings, see the NATIONAL GEOGRAPHIC MAGAZINE Cumulative Index, 1899-1953, obtainable from the National Geographic Society's headquarters.



Champion Rancho Dobe's Storm Has Twice Won Westminster's Best in Show Trophy

Louis Dobermann of Germany developed the Doberman Pinscher in the late 1800's to combine the terrier's agility with the shepherd's strength. Storm, owned by the Len Carrys, of Can Cots, Connecticut, won 17 Best in Show victories in 25 competitions. He retired to stud after this appearance with his handler, A. Peter Knapp (left) before judge James A. Farrell, Jr. Storm captured Westminster's James Mortimer Memorial Silver Trophy for Best American-bred in Show and its sterling silver bowl (right) for Best in Show.

Canada, several from California (a great State for dogs), and the rest from ten or more States.

Most of the judges have but one or two breeds assigned to them, but usually there are four "all 'rounders" who have a large number of dogs to judge, including most of the rarer breeds. The all 'rounder is usually a man who is licensed by the American Kennel Club to judge all breeds and is paid a fee. The vast majority of judges are amateurs who are licensed for a comparatively few breeds.

The judges for the groups and those for Best in Show have no other assignments; so the dog that wins Best in Show must be passed upon by three different judges.

How does a judge get to be a judge? First of all, he has to have the background, preferably as a breeder and exhibitor. On his application form, which goes to the American

Kennel Club, he has to give his background and answer questions which test his knowledge of dogs, of the duties of a judge, of ring procedure, and the like. His name is published in the American Kennel Gazette, the official organ of this body, and anyone may write to support or oppose his application.

Would-be Judge Is Judged in Turn

Then comes a period of apprenticeship, in which the applicant serves under a licensed judge who is doing the breed for which he applied. The apprentice does this three times, under three different judges. After each show he writes a critique of the dogs present—and the judge writes a critique of the apprentice! These documents then go to the American Kennel Club, where they are evaluated along with the material already in the file.



A St. Bernard Baby Sitter Blinks a Sleepy Eye

Massive head and imposing height (more than 27 inches) make the St. Bernard a picture of power. Hansel of Sunny Slopes is owned by the Howard Parkers, of Stamford, Connecticut. A placid disposition qualifies him as a companion to children. His friend is Gordon Ivins, of Trenton, New Jersey.

When the apprentice has successfully survived these ordeals, he is qualified to judge—though disappointed exhibitors later may dispute the use of the word “qualified” with vehemence, if not with violence.

The theory of judging is based on what are called the “standards.” Each breed has a written standard of perfection which supposedly describes the ideal specimen. The dog that comes closest to that standard, in the opinion of the judge, is placed first.

In practice this is not as simple as it sounds. To begin with, no mere mortal or group of mortals can perfectly describe a perfect dog in words. Next there is the fact that probably no two people will interpret that standard in exactly the same way. Then there are added factors and complications, such as the physical condition of the dog, the condition of his coat, the way he shows, temperament, and other

small but important things that enter into the final judgment.

When it comes to group and Best in Show judging, the theory is the same—which dog comes closest to the standard of perfection for his or her breed. It is an old adage among dog people that judging poor dogs is the hardest job there is; so it is not surprising that group and final judging are not considered especially difficult.

Only Prizewinners Can Enter

Westminster's pre-eminence is emphasized by the fact that it is quite literally the blue-ribbon show. To be eligible for entry a dog must win a first prize at another recognized show in this country or in Canada. (Puppies are exceptions to the rule.) This regulation was put into effect when lack of space in Madison Square Garden forced the club to

limit entries to 2,500 dogs. The number may run somewhat over that figure—as it did last year, for example—because, under the rules, all entries in the mail delivery that brings the entry blank for the 2,500th dog are accepted.

Actually the rule works little hardship on a dog of quality, for there are dog shows now in every one of the 48 States, Alaska, and the Hawaiian Islands. Some may have but 200 dogs entered; others may have 2,000. But they are all important parts of the whole picture. These are the clubs that make up the American Kennel Club, the supervising body that registers dogs in the Stud Book, checks and records show results, enforces regulations, and performs innumerable other thankless tasks.

Preparing for Dog Days in February

As much as five or six days before the show goes on, huge trailer trucks start coming in to Madison Square Garden. Benching is unloaded and set up in the exhibition hall, one floor below the arena, with signs to show where the various breeds are located. Dogs coming from far away may arrive two or three days before the show opens, and facilities must be available for them.

The night before the show opens there is usually a hockey game in the arena. Belowstairs the benching is in place, and hundreds of dogs are already sleeping in their stalls. The whole organization is waiting for the move upstairs.

As the game ends, hot water is pumped through the pipes to start the ice melting. As it breaks up, motor trucks push it into a chute and out of sight below.

When the floor is dry the all-night task begins. The sideboards for the rings are set up and green rush mats are laid over the entire floor of each ring, giving the dogs a good footing on which they can move without slipping. Seats for spectators are placed around the rings, telephone lines are run from each ring to the benching downstairs, and big blackboards are erected for posting the awards.

Hunting in Heart of New York City

The whole first day, from 10 a.m. until about 11 p.m., and the entire morning of the second day are devoted to breed judging (page 111). Then the rings are dismantled and the whole floor of the arena is transformed into one emerald-carpeted ring for the group

judging. Best hound, best toy, and best non-sporting dog are chosen; also the best brace (two of a breed) and best team (four of a breed) in each of the six groups.

By this time it is 5 o'clock and a sudden change takes place. Corn shocks, small evergreens, and piles of brush are brought into the ring, and Westminster, harking back to its founding days, presents an indoor demonstration of how bird dogs work in the field.

This is a remarkable performance, for these are true working bird dogs going through their paces in the most alien environment of which one can conceive—before the eyes of thousands in the heart of a great city (page 104). They point live birds and demonstrate their retrieving skill with "planted" game. Understandably, the shooting is done with blank cartridges.

In the evening the climax builds up slowly: Best sporting dog is judged, then best working dog and best terrier. Next there is a break in the tension as a special performance is put on. It may be some Border Collies working a band of live sheep, or perhaps a guard-dog demonstration, or a few selected bird dogs displaying their skill.

Now comes the beautiful class with six teams of four dogs each competing for Best Team in Show (page 112). Next, six pairs of dogs compete for Best Brace in Show. And then comes the finale.

Choosing the Winner of Winners

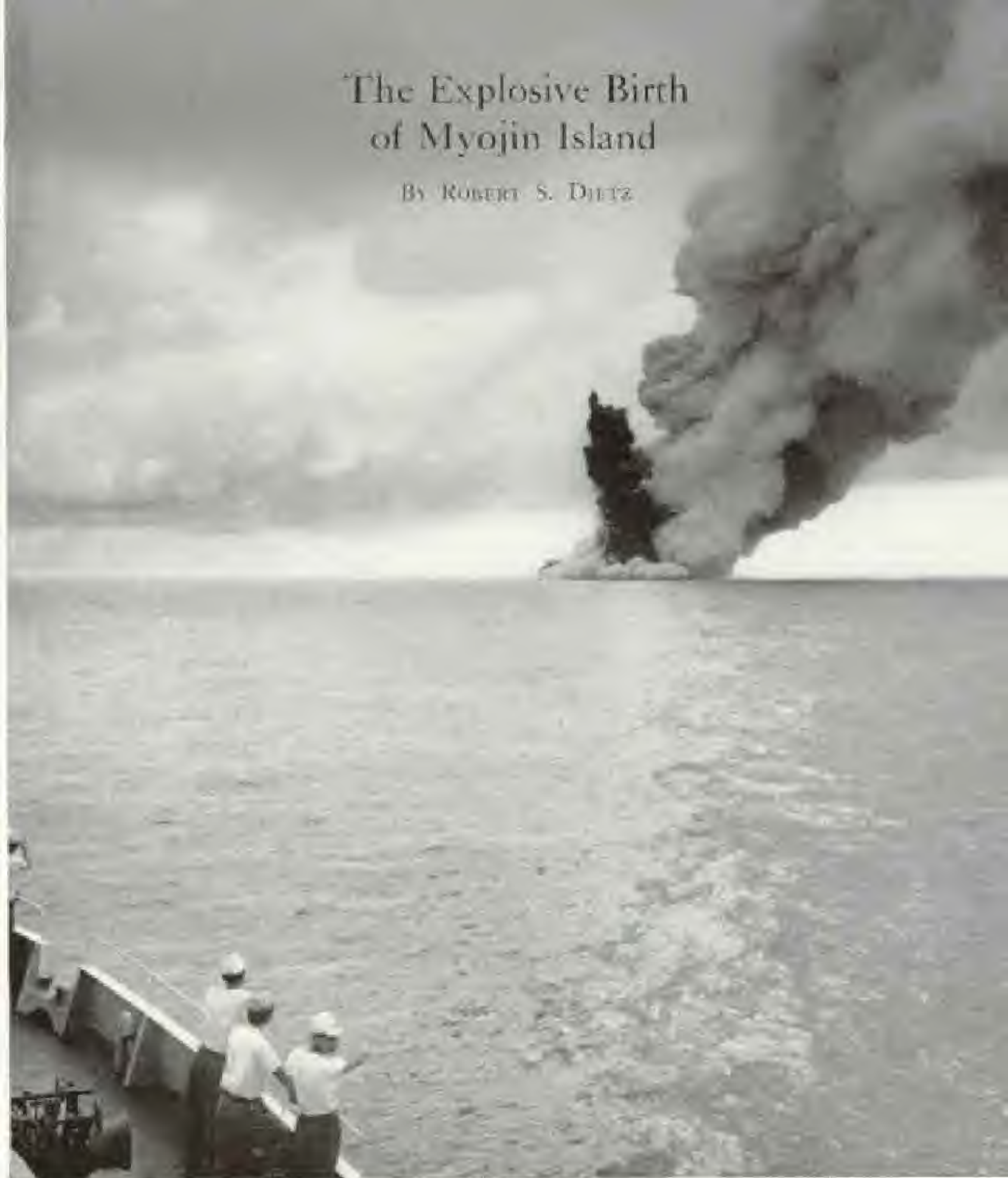
Six dogs stand with their handlers in the middle of the green expanse. The peak of canine fame looms within the grasp of each. The television cameras swing as the judge moves from dog to dog. A hush descends on the great arena—shattered at intervals by applause from partisans as each contestant gulfs up and down the ring.

The judge surveys them one final time and turns, giving no hint of his selection, to go to the judge's table. There he writes down his award. He turns once more to the ring, walks forward, and motions the winner to the center. Another dog has reached the pinnacle; another Westminster has run its course.

In February, 1892, that famous publication called *Frank Leslie's Illustrated Weekly* reviewed the Westminster show of that year and observed: "It might indeed very properly be called the national dog show." Today, more than sixty years later, the same may still be truly said.

The Explosive Birth of Myojin Island

By ROBERT S. DITZ



117

New York Times-Archie Pomeroy

A Volcano Clears Its Throat. Noxious Vapors Blacken the Pacific Sky

RARELY has man had an arena-side seat at the creation of a volcanic island. Such was his opportunity at the birth of Myojin, whose Japanese name means "Bright God." The awesome spectacle occurred 230 miles south of Tokyo in September, 1953.

Rising 5,000 feet from the bottom of the Pacific, the volcano made three attempts to add an island to the 1,500-mile-long chain stretching from Japan to Guam.

After the initial explosion the volcano extruded lava quietly. But when water congealed the molten rock, sealing the vent to the underground magma chamber, the monster blew its top violently and repeatedly.

One explosion destroyed a Japanese hydrographic survey vessel, killing 31 men (page 125).

On September 18 the sailors above watched Myojin's birth pangs from the deck of *Shikine Maru*, a Japanese Maritime Safety Board patrol craft.



A Tornadolike Funnel Spirals into Myojin's Towering Plume

Long ago the earth's crust buckled into a ridge along a line from Japan to Guam. A row of undersea volcanoes grew on the crest and laid the foundations of the Bonin and Marianas Islands.

Myojin, one of these volcanoes, has been trying to build an island for years. Observers reported it rumbling in 1896, 1906, 1915, 1954, and 1946.

Many islands, among them the Aleutians and Kurils, were born of volcanoes belonging to the so-called Ring of Fire encircling the Pacific. Bogoslof, jumping-jack island in the Bering Sea, has changed shape half a dozen times since 1796.

A blast heard 3,000 miles destroyed Krakatau Island in Sunda Strait in 1883. 36,000 people perished. Krakatau exploded again last October.

Martinique's Mount Pelée, exploding in 1902, destroyed the city of St. Pierre and snuffed out 30,000 lives. A National Geographic Society expedition, hastening to the Caribbean, found a type of eruptive action previously unknown as a killer—suffocating dust and steam.

In 1912 a powerful explosion shattered Mount Katmai on the Alaska Peninsula. Its eruption scattered dust across North America and cooled an entire summer. Rains of sulphuric acid destroyed Canadian vegetation; fumes tarnished brass as far south as Washington State. Mount Katmai left as its legacy the Valley of Ten Thousand Smokes, discovered, named, and explored by seven National Geographic expeditions.

Myojin's cloud of steam and sulphuric fumes here billows skyward. Lava heated to an estimated 1,700° F. squeezes from the crater and builds a new island. This close-up was made from *Shibine Maru* on September 13.

The whirlwind on the left was caused by warm air just above the sea rising suddenly through a cool layer to join the volcanic updraft. Spiraling into the steam cloud, it created a vortex not unlike that left by water draining from a bathtub. Besides the tornado effect, observers noted exploding fireballs, flashes of lightning, and claps of thunder.



Bayonnaise Rocks, Rim of a Mighty Crater, Guard the Approach to Myojin

Eighty explosions or groups of explosions built and destroyed Myojin No. 1. Of these, man saw but 13. News of the others flashed by ocean's natural telegraph service to electromechanical ears 5,300 miles away across the Pacific.

At Point Sur and Punta Arenas, on the coast of California, the United States Navy maintained two underwater listening stations, part of a system called solar (sound fixing and ranging). Recording stations on shore listened in on cables running down the continental slope to hydrophones deep in the sea. Designed to locate ships in distress, solar also detected sounds of natural origin.

Sound waves from Myojin raced through Pacific waters nearly a mile a second, more than four times the speed of sound in air. At that velocity it took them 97 minutes to reach California.

Solar recorded Myojin's first weak explosion early on the morning of September 15. Twelve hours later a heavy blast sent "tidal" waves racing across the sea at 150 miles an hour. The waves

struck Hachijo Island, 75 miles to the north.

Myojin's initial explosions cleared an exit for lava and vapors demanding release from the earth. By the time the first visitors sailed close, the volcano had built a steaming island several hundred feet wide.

After *Shikine Maru* left the scene, Myojin exploded uninterruptedly for 70 minutes, but only solar's ink squiggles took note.

A United States Air Force plane, visiting Myojin on the 22d, found only a few black rocks jutting above the sea. Ten minutes after the flyers departed, Myojin fired 10 explosions in 40 minutes. Any one of these could have felled the plane had it been flying low.

Soundings reveal that Myojin is the central vent of a 7-mile-wide caldera, a dish-shaped depression at the summit of the sea mountain.

Bayonnaise Rocks are the only part of the saucer's rim rising above the sea. The eruption that created them went unrecorded.

Myojin Lifts a Shattered Dome of Water, Steam, and Ash, Then a Mushroom Cloud

The sea was calm on September 23 when *Shinyo Maru*, another Japanese research vessel, arrived off Myojin. Suddenly a black, angry dome arched out of the water five miles ahead. A second explosion occurred when the ship was a mile away.

Prof. H. Niino of the Tokyo College of Fisheries requested the crew to go forward to pick up pieces of floating pumice, an exploded lava so honeycombed with gas spaces that it becomes buoyant. As he lowered a dip net over the rail, the sea welled up several hundred yards ahead.

"In the next moment," he recalled, "the swell looked like a boil on the surface. Then it bloomed, like a monstrous flower, 20 feet high and 600 feet across. Instantly water began to fall like a cat-ract while the dome's center pushed up to a height of 100 feet.

"Suddenly a black mass burst out from the dome's right side. Volcanic bombs (incandescent chunks of lava) sailed into the sky. Steam from the lower part of the cloud swirled across the sea to meet the boat. Hot pumice fell like rain, hissing as it dropped into the water."

The explosion filled the air with a roar. Air-borne concussions buffeted the crew. *Shinyo Maru* retreated at full speed. A wave like a tidal bore's overtook the ship and tossed her like a canoe in rapids.

A small part of the ocean around Myojin may have been composed of new or "juvenile" water just liberated from the earth's interior. Some scientists believe that such water, squeezed out billions of years ago when the crust began to rind, created the oceans and built them to their present levels. New waters from volcanoes increase the sea's volume yearly.

These pictures were taken as *Shinyo Maru* stood five miles from Myojin.

Top: Fifty seconds old, the cloud spreads across 1,500 feet. Lower: Five minutes later the initial blast is spent. Surface winds rushing into the partial vacuum lift the cloud skyward to an eventual 15,000 feet. Unseen by the camera, an underground chamber stands open. Molten rock spews out, boils the sea water, and feeds steam into the cloud.

120



New York Times-Archie Press

Jack-in-the-Box: Myojin Is the Despair of Map Makers

Whether to locate or ignore this dot on the Pacific (map, lower left) becomes a problem as volcanic forces alternately lift it above the sea and blow it off the face of the earth.

If water were as clear as air, observers could see a long line of submarine volcanoes stretching from Japan to Guam. Comparatively few thrust peaks into the air. Some have flat tops, which may be the result of erosive wave action before they disappeared beneath the surface.





A Cloud Like an Atom Bomb's Leaps Out of the Sea. Ashes Rain from Its Overhang

Plutonium and TNT blasts take place in a fraction of a second. Detonating, these explosions produce terrific shock waves. Erupting volcanoes spend their energies over longer periods. September 23's billowing plume lacks the doughnut-shaped shock-wave cloud that has encircled the stems of various atomic clouds. Six minutes old, it spreads 4,000 feet across its base and towers 15,000 feet.

Pages 122 and 123: Desk-size bombs are flung like pebbles from the edge of the ash-blackened cloud. *Shinyo Maru* stood a mile away last September 23 and watched the island destroy itself. (New York Times-Asahi Press)







Myojin No. 1 Disintegrates Before the Camera's Eye. Flying Lava Wears a Collar of Steam

September 25. The dying island's last gasp is a steaming waterspout 90 feet high. Huge blocks of pumice drift above the sunken crater. Opening one of these

Pumice from a former Myojin eruption has been found as far away as Two Jima (map, page 120). Bits picked up on east African beaches have been identified

as having floated from Katakata's 1883 eruption.

Sailing away, Shinyo Maru left tranquil waters, a trip that destroyed another vessel the next day (page 126).



Japanese Research Ship
Kaiyo Maru 5, Docked at
Kobe, Japan



↑ Ship and 31 Men Perished When Myojin Blew Up

On September 24 *Kaiyo Maru 5*, a research vessel of the Maritime Safety Board, sailed into Myojin's waters.

Finding the island gone, *Kaiyo Maru* is presumed to have ventured directly above the crater. At 12:23 p. m., a time determined by solar, Myojin blew its top again. Volcanic missiles shelled the ship. Water was blown skyward. *Kaiyo Maru*, dropping into the void, was splintered. Nine scientists and 22 crew members vanished. Their story was told by lava-pitted wreckage found three days later.

← A technician aboard *Shinyu Maru* lowers a Nansen sampling bottle to measure temperature and salinity changes caused by the volcano. Fisheries experts found marine life destroyed by Myojin's flood of chemicals.

Opposite, top: Myojin Island No. 2 emerged with little fanfare on or before December 9. Here, on the 27th, the volcano rises more than 100 feet.

Lower: Officers of a Tokyo College of Fisheries research ship drop a wreath in memory of their 31 compatriots. By February 1, 1953, the second Myojin had thrust a million and a half tons of rock above water. Its height was 300 feet.

→ Associated Press and H. S. Shaw





128

Yonkers Press

✦ A Shower of Sparks, a Belch of Vapor, and the Second Myojin Is Gone

Seen from an airplane on March 11, 1953, this patch of discolored water testified to the volcano's second failure to build an island. Twenty-foot waves hit 75-mile-distant Hachijo when Myojin blew up again.

✦ Myojin No. 3 Is Born: a Plug of Lava Forms Its Peak

On April 14 the new island appeared to be 600 feet long and 150 high. A hardened spine of lava was rising slowly out of the crater. Last October an American research vessel found Myojin gone again.

U. S. Air Force, Official



Teaching ABC's to Eskimo Youngsters on Alaska's Lonely King Island Is a Heartwarming Experience for an American Couple

By JUAN MUÑOZ

With Illustrations from Photographs by the Author

THIN ice on the Snake River mouth crackled as our umiak, a walrus-hide boat, rammed through it. The lights of Nome, Alaska, twinkled behind us in the clear, cold October night; above shone the northern stars, dimmed by a beautiful aurora.

Surrounded by Eskimos returning to their village on King Island, my wife Ric and I huddled shivering on our piled belongings. The Alaska Native Service ship, the *North Star*, lay at anchor three miles offshore, waiting to take us to our winter home.

Cut Off from the World for Months

Our destination, rocky King Island, with a total area of two and a half square miles, lies off Seward Peninsula in the Bering Sea, 85 miles northwest of Nome (map, page 130). Its village, Ukiyok, clings to cliffs on the south side of the island.

During summer months King Island's Eskimos move to Nome for seasonal jobs and to carve walrus ivory for the tourist trade. In the fall they return again to nine months of isolation. This time my wife and I were to share their lonely life; we had been employed by the Alaska Native Service to conduct a school for King Island's children.

As we drew alongside the *North Star*, the hoist was lowered; our skin boat and its occupants were swung aboard. The forward hold had been cleared of freight to make room for King Island's entire population of 150 Eskimos, together with several dozen travelers from Little Diomedé Island. Each camped for the night amidst his piled belongings.*

Since there is no means of transportation to and from the island during nine months of the year, everything must be bought in Nome before this annual fall departure. In jealously guarded piles we saw seal pokes full of fresh berries picked on the mainland and preserved in seal oil, walrus-skin bags bulging with newly acquired dry goods, radio batteries, and cigarettes. Supplies taken on the boat would have to last until July, when the Eskimos would return to the mainland.

Early the following morning we were on

deck. Behind us snow-covered hills of Alaska vanished in the distance. To the north Bering Strait and the Siberian mainland made a spectacular backdrop for the brilliant blue water.

Directly off the bow we had our first view of King Island, rising abruptly from the sea. The 1,196-foot crest of the island was covered with snow, but the steep sides were still bare.

At last we were able to distinguish the village that would be our winter home. It looked for all the world like a prehistoric settlement. Closer view did little to destroy this illusion. Only two buildings, the church and the schoolhouse, had vertical lines and coats of white paint. Everything else clung to the cliffs at random angles (page 131).

The *North Star* dropped anchor a few hundred yards offshore. Umiaks were lowered, and unloading began. Ukiyok's Eskimos worked for three days to move the mass of personal belongings and the winter supply of food and fuel.

Dogs Meet Returning Islanders

Eager to see our new quarters, I went ashore in the first skin boat. Immediately we were surrounded by packs of barking, tail-wagging dogs. They had been left behind to shift for themselves during the summer months. Foraging among the rocky crags, they had hunted puffins, auklets, California murres, and gulls. All appeared in the best of condition.

The large three-story schoolhouse was my first objective. In the basement were workshop, storage space, and engine room.

A narrow stairway led to the second floor. Here I found a large classroom; separated from it by a hallway was the living-dining room and kitchen we were to use. The third floor was taken up mainly by attic space and our bedroom. Across the front of the building, in both the living room and the classroom, windows afforded a view of King Island's restlessly changing seascape.

* See, in the NATIONAL GEOGRAPHIC MAGAZINE: "North Star Cruises Alaska's Wild West," by Ames Burg, July, 1951, and "Alaska's Russian Frontier, Little Diomedé," 18 illustrations from photographs by Audrey and Frank Morgan, April, 1951.



130 Drawn by Robert W. Northern

King Island Dots the Bering Sea

Only 21½ square miles in area, the island lies 85 miles northwest of Nome, Alaska, and 110 miles south of the Arctic Circle. A village of 150 Eskimos perches on its southern cliff (opposite page).

Leaving the school, I met an elderly woman struggling with a heavy seal poke. I offered to carry it for her. Shouldering the load, I followed her up the steep stairs that serve as village streets. Soon we turned off the main stairway onto one of the plank walks that lead to various levels of houses. Then we crawled under, over, and around houses to get to the one in which she lived.

Front Porch 30 Feet off the Ground

Her house was typical of the island's dwellings. Because of the steepness of the cliff—about 45 degrees—the backs of the houses rest on bedrock while the fronts are supported by long poles. From her porch to the ground was a drop of more than 30 feet.

She motioned for me to enter through a small doorway and then explained that this, the first of two rooms, served as a shed for general storage. Food and family hunting equipment were kept here. Here too the dogs of the household had their sleeping quarters.

From the shed we crawled through a 2-foot-square doorway into the main living quarters, a room about 10 feet square with a ceiling not more than 5 feet high. In it the family ate and slept and the women worked.

Rooms were heated by a seal-oil lamp or, occasionally, by a small oil stove. During the day the bedding was rolled up in a corner so that the family, often as many as six people, could take advantage of the limited floor space.

When the unloading was completed, the *North Star* weighed anchor and, with a cheerful toot, departed for other ports of call. As we watched her disappear, I couldn't help wondering what lay ahead for us. With the ship went our last link with the rest of the world; we would not see another outsider for months. Like it or not, we were on King Island to stay.

Eskulta Means Schoolteacher

Soon we found that we were going to like it. During the days before the start of school, Rie and I had our first introductions to our island associates. They went out of their way to make us feel at home.

We learned that 70 percent of King Island's adults do not speak English. When not in the company of white men, young and old alike speak Eskimo.

In their comments among themselves I heard the word *eskulta* over and over. Eventually I realized that it meant "schoolteacher."

From our English-speaking visitors we learned that, in one way or another, most of the King Islanders are related. The "big, happy family" cliché certainly applies here. The ever-happy and fun-loving King Islander is always ready to help a brother, sister, or nephew whenever help is needed. If a child becomes ill, all its relatives—the entire village—show concern.

One visitor to our school, an Eskimo woman who spoke excellent English, announced that in previous years she had been employed as an assistant. Barbara Kokuluk's duty had been to instruct beginners in the English language. We immediately hired her.

The older children were assigned to me, the younger ones to Rie, and the beginners to Barbara. Following custom, we kept the schoolroom open evenings for the weekly game, library, sewing, and music nights.

Rie and I had brought raw reindeer skins from Nome to be tanned and made into parkas. I asked one of the men to show me how to tan them, and he suggested I come to the clubhouse for my lesson.

He led me to the mouth of a small tunnel. "Don't bump your head," he cautioned, as he ducked down and vanished into the dark hole.

I followed, slowly crawling a distance of



A Village's Entire Population Rides *North Star* Home for Winter

Eskimos who have spent the summer in Nome return to isolated Uktvik village to face long, dark nights. They support themselves by hunting seal and walrus and catching fish. Here the author and his wife shared the Islanders' lonely life for nine months (page 129). Walrus-hide hunting boats on the ship's deck will carry supplies ashore. Landings can be dangerous, for the village has no beach. Sea ice will form quickly early in December.

20 or 30 feet. Ahead I could see a dim light from a hole in the top of the tunnel. The light momentarily vanished as my companion squirmed through. I quickly followed suit.

I stood up and found myself in the middle of a large room which we had entered through a hole in the floor. The room was unfurnished save for an old rusty stove. Men sat on the floor carving ivory, tanning reindeer skins which they buy from the Government-protected herds on Nunivak Island, and lounging,

Teacher Learns to Tan Hides

They invited me to sit down. I chose a box next to my friend and settled back to watch him work on a reindeer skin. He explained that he had been dampening it for nearly 24 hours, being careful not to wet the hair. This moistening made the once-stiff skin soft and easily workable.

To my surprise, his next step was to spread the skin out, hair side down, and sprinkle it with flour. This, he said, would take up the extra water. He then took a sharpened piece of slate and methodically scraped the hide, removing all the adhering flesh and sinew. That done, he worked the skin, section by section, twisting it in his hands.

After I had watched for a while, he sensed my restlessness. The softening would take several hours longer. Would I like to return later? The other man explained that I had seen most of the process by now and that only the continued handworking and one final scraping remained to complete the job.

An Eskimo thrust a finished skin into my hands. Surprise as well as approval must have shown on my face; the Eskimos grinned from ear to ear. It was as soft and pliable as any commercially tanned skin. I went home to try my luck with the skins I had brought.

Ice Means Good Hunting

One chilly December morning I stood on the school porch talking with a neighbor. He suddenly pointed out several glassy, still areas on the ocean. "Ice forming below," he said. "Tomorrow ice there."

The King Island Eskimos claim that ice forms on the bottom of the ocean and then floats to the surface. Surprisingly enough, ice was there the following day. By evening a thin layer covered the water as far as we could see. Winter had begun.

Our daylight hours had been growing shorter. Here, close to the Arctic Circle, late December days had only about three hours

of actual sunshine, with another hour of twilight at each end of the day. By June, when we were to leave, it was never dark. The sun dipped only shallowly below the horizon for a couple of hours.

The first day the ice was strong enough to support a man's weight, every hunter went out on it. Almost all returned with one or two seals. The long period of semistarvation was over; the village became alive with laughter and gaiety.

Every schoolboy and most of the girls went down to the ice to help their fathers or older brothers drag the 60- to 70-pound carcasses up the cliffs to their homes. It became a common sight to see four or five small parka-clad boys struggling over the rocks and dragging a big seal at the end of a rope (page 143).

From time to time I was invited to accompany a hunter for a day on the ice. This was more hard work than sport. The 20- to 30-foot pressure ridges of jumbled ice made walking a strenuous job. Hour-long waits beside open leads on the ice, hoping for a seal to show its head, chilled me to the bone.

An ever-present danger was that a sudden shift of wind or current might widen the leads and carry us out of reach of the island. There would be little chance of getting back. Every few years some King Islander is lost in this manner or is forced to spend cold hours on the ice before a change in the current allows him to return home. I acquired a great respect for these men who venture forth daily, in every kind of weather, in search of food.

Fireworks for New Year's Eve

Before we knew it, Christmas was upon us. The entire population of the village is Catholic; the island has its own priest and church. From the teaching of the fathers, the natives have come to appreciate Christmas.

Basically, the celebration on King Island differs little from that on Manhattan Island. Religious services are held; the children present a Christmas play; gifts are exchanged; and the villagers enjoy games and dance parties.

On New Year's Eve fireworks, saved especially for the occasion, were set off high on the cliffs. Roman candles arced gracefully out over the ice, their flaming, many-hued lights reflecting on its glassy surface.

For us the festive week had vivid highlights. During the community dinner, which consisted of both white man's food and native

(Text continued on page 141)



Eskimo Children Play Hopscotch on a Narrow Ledge Above Ukiyok Village

Winter home of 150 people, rocky King Island lies 15 miles west of mainland Alaska in the Bering Sea. Anchored ice clings to the shore. The author and his wife lived and taught school in the building at lower right.



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131

With Alaska's Flag Hastily Flown in Reverse, the Author's Wife Signals a Plane onto Ullivok's Red-streamered Runway

King Islanders chopped away pressure ridges on sea ice to smooth a 1,500-foot emergency strip. When turbulent air prevented a landing, the pilot dropped supplies from 1,000 feet. Some, falling on floes, drifted to sea. At the time of the author's visit, only three airplane landings had ever been made on King Island.

King Island Fishermen Chisel Holes in Sea Ice; with the Scoop They Remove Chips from Bitterly Cold Water

Bits of bright toothbrush handles serve as lures for halibut (page 137). Hard-as-boards boots permit intemperate fishermen to remove catches without exposing fingers to the cold. Crabbs, clutched fast on hookless lines, must be pulled up gently; they let go if they touch the sides of the hole.

135

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136

↑ After the Exciting Walrus Shoot Comes the Firesome Task of Butchering

Walrus, shot in mass attacks as they ride north on ice pans, provide King Islanders with hides, meat, and ivory. Here two animals are stretched on the ice, another is rope-anchored, and a 200-pound calf is dragged half out of water. The author took part in this hunt.

✦ An Eskimo Woman Splits Walrus Hide with Steady Hand and Sharp Knife

Outer skins cover umiaks, the Eskimos' big canoes; the inner layer goes into roofing. Only old hands are trusted with the delicate splitting job. This mother has had glasses fitted in Nome. Dogs and sleds have already hauled away the walrus meat.





This Time Only Small Bullheads Were Caught in the Hole Made with Chisel and Scoop
 Like her sisters, this islander wears a gay cover over her reindeer-skin parka. Mukluks, her ornamented seal-skin boots, are waterproof for wading. Hunters wear white canvas jackets for camouflage on ice (opposite).



When the Hunters Return with Tons of Walrus Meat, Wives Get Busy Cleaning the Skins

Hides (storing the ice must be fleshed and split (page 126)). Meat and blubber are stored in a cave, a natural home freezer. These children lie on a rock and watch the excitement. An unuk (come awaits a walrus-hide cover. Gasoline for outboard motors is stored in the drums.

As Women Pare Blubber from Sealskins, Hungry Dogs Stand Watch to Gobble Any Morsel Thrown Aside
Women flesh skins with the *ula*, a broad steel blade shaped like a wedge of ice. Their collecting boards are heirlooms, generations old. This skin will be converted into soft, water-resistant boots; the carcass (foreground) will be eaten; the oil will be burned in lamps.

139

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Mrs. Muñoz Cuts and Eats *Mukluk* Eskimo Style

The author describes mukluk as "whale skin with about one inch of blubber and having a flavor similar to that of hazelnuts." He found that boiling improved the taste. Mukluk from the white whale is particularly delicate.

Mrs. Muñoz made her own cloth parka cover. Her dogs are family pets. Eskimos leave their dogs to forage on King Island when they go to Nome for the summer. A mournful chorus of howls marks their departure.

✦ Nine-year-old girls take baby sisters piggyback for an airing. After wintering on King Island, they have returned to Nome, where their parents carve walrus ivory for sale to travelers. Most islanders own temporary homes just outside Nome in a settlement nicknamed "King Island Village."

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Entomology by Lynn Hoffer

140



dishes, Rie and I were introduced to an awesome delicacy popularly known as "Eskimo ice cream."

A pinkish mass, it was dotted with red and black "beads." The black ones, an Eskimo girl pointed out, were the berries with which we had become familiar in Nome. The red ones were raw fish eggs. These were held together in a pasty goo of raw reindeer fat and seal oil. We smiled bravely and swallowed hard to get this native delicacy down.

During this week we saw our first Eskimo dances. The men's dances were lively and exciting to watch. There was much stamping of feet and waving of arms to the rhythms of chanting drummers. The drums were made of walrus stomach on wooden hoops.

The women's dances were less vigorous. Sitting on long rows of wooden benches, the dancers swayed gently, moving only their arms and torsos.

Games of strength and endurance followed the dances. Most popular was a tug-of-war between pairs of men, in which ropes were attached to the necks of the contestants rather than being held in the hands.

Islanders Like Their Crabs Raw

During the winter months fishing was excellent. Even on bitterly cold days village women of all ages, up into the seventies, made their way down to the ice to fish as long as the brief light lasted. Enormous crabs were their chief prize, though catches of ugly little bullheads, or sculpins, tided them over the days when nothing else would bite. A good day's catch would bring as many as 15 huge crabs. These were eaten raw, frozen, or boiled. The unsightly but tasty bullheads usually were dried and stored (page 137).

One evening early in February an unfamiliar voice boomed in over our radio. It turned out to be the radioman aboard the U. S. Navy icebreaker *Burton Island*. The ship was anchored 10 miles off and was expected to come to King Island early the next morning.

The news passed quickly around the village. Men and boys immediately vanished into the clubhouses and there they remained the entire night, carving ivory souvenirs to trade for cigarettes and candy.

The following morning every man, woman, child, and dog was down to watch the *Burton Island* as she rammed the anchored shore ice to secure a safe berth. Most of the villagers were dressed in their fanciest parkas.

The dogs, having caught the excitement,

began a wild free-for-all fight. Into this whirling, snarling mass of 30 or 40 dogs leaped a handful of screaming, dancing Eskimos, trying in vain to break up the battle. The ship's crew crowded the deck to watch.

The fight finally over, the Jacob's ladder was lowered. All of us scrambled aboard. The villagers immediately went below to trade their ivory. My wife and I were introduced to the captain and other officers. Then began the arduous task of rounding up patients we thought should be examined by the vessel's doctor and dentist.

Ship Brings Diversion—and Colds

By afternoon the ivory had been traded and all the patients treated. A ship movie entertained the islanders with the daring exploits of Jesse James, while they ate fresh fruit and cake served by the crew. When the icebreaker pulled away, a tired but happy group of smoking, gum-chewing, candy-munching Eskimos marched back to the village.

The visit from the *Burton Island* is a yearly event; and, as surely as spring follows winter, so a series of colds follows the visit from the icebreaker. Within a week men, women, and children filed into the clinic for treatment.

Directly in front of the village was a large field of anchored shore ice (page 133). As the days grew longer, this area became the scene of lively games of baseball, tag, and soccer. On Saturdays we conducted organized sports for the boys, while the girls remained huddled around the schoolroom stove, sewing and knitting.

Accustomed to warm-weather baseball games in the States, I was always amused to see the teams, bundled in fur parkas, sliding around their icy playing field, using blocks of snow for bases.

Among numerous village duties, I had to help with the native store accounts. The store, the only commercial establishment on the island, was started with a Government loan. In their isolation, money means little to King Islanders; barter prevails. Ivory is traded for tea, coffee, milk, oats, dried fruit, flour, and sugar.

In the summer the collected ivory is sent to a clearinghouse and sold, and the money is used to purchase more groceries for the following year. Unfortunately the store's working capital is not sufficiently large to stock a wide variety of supplies, but it does help the people through the long, dark winter.

With the advent of longer daylight hours

in March, Rie and I often went for walks after school hours in search of new spots of interest. One of these walks took us to a big ice cave where the villagers store meat.

We entered through the mouth, which is well over 200 feet high, and dropped down into an immense chamber. A dim light glowed in the far corner of the cavern. As we approached it, we found an Eskimo woman huddled beside a lantern getting meat for the family dinner. She was greatly pleased to see us, as was every King Islander whenever we showed an interest in learning more about island ways, and offered to show us around.

We went from chamber to chamber, climbing over narrow ledges and up and down ladders, all the while stumbling over frozen chunks of meat. Our guide explained that each family had its own storage place. To us there seemed little separation of the personal caches, for the caverns and paths were literally paved with frozen walrus cuts.

I marveled at the enormous supply of meat in the cave. The villagers always keep more than a year's supply on hand, to tide them over in case of a poor hunting season.

On another hike we came across one of the two abandoned village sites on the island. Here we found ruins of small rock-and-earth dwellings with tunnel entrances. Near by we discovered ancient graveyards in which the usual household utensils, toys, and beads had been placed beside their former owners. The dead were simply put on top of the ground and covered with rocks to keep away hungry dogs and birds.

In the present community cemetery, located on the rocks a hundred feet above the village, the same system of above-ground burial is employed, because of lack of soil on the island. But today the bodies are usually placed in homemade tarpaper-covered coffins.

With the arrival of spring, the snow gradually melted from the sides of the island, birds reappeared, and the ocean ice started drifting northward. The walrus herds, after spending the winter in more southern waters, began their annual hitchhiking trip on ice cakes back to the Arctic Ocean.

Walrus Herds Bring Excitement

Spring is by far the most exciting time of the year to the King Islander. Villagers bring their large umiaks from the winter storage racks. Men are stationed high above the village 24 hours a day to watch the drifting ice through binoculars for signs of walrus.

When the ungainly animals are sighted, excitement pervades the entire village. People



race up and down the steep stairs, calling to each other and struggling with heavy outboard motors. Gasoline, rifles, and 6-foot harpoons are readied in preparation for the hunt. When the boats have been launched, a strange quiet descends upon the village. Only women, children, and old men remain.

It was 3 o'clock one morning when I was awakened by a shout from the captain of one of the umiaks, informing me that it was time to get going—walrus had been sighted. I dressed hurriedly, crammed a sandwich into my mouth as I ran down the stairs, and arrived in time to help push the heavy boat into the water.

We headed due south and for two hours



Dogs, Boys, and Men Drag Home a 300-pound Bearded Seal Skin on the Ice

Sealing begins when the first ice forms. Most big bearded seals are caught late in the season. Their hides provide leather for boots and kayak covers; intestines are converted into waterproof parka covers.

crossed open water before we reached the pack ice. The harpoonmen studied the ice through their glasses. We drew alongside an ice pinnacle and cut the motor. A scout climbed the highest point and scanned the horizon. Everyone was quiet.

Spotting Walrus by Sound

"Walrus!" said one of the men. "Hear 'em?"

From the distance came a low roaring sound: it was barely audible in the wind. Another grinned and said, "Lots of walrus."

"They are at least four miles away," the captain told me.

Four miles! Hidden as they were by this jumbled mass of broken ice, would we ever find them? The hunters confidently loaded their rifles, and I realized that there was little doubt in their own minds.

The men nosed the boat through the floating ice, stopping frequently to listen and scout ahead. Finally, after what seemed an eternity of working our way through the mass of ice, a scout said two words in Eskimo. By the excitement that ran through the crew I knew



Villagers Returning from a Seal Hunt Unload Gear and Turn Over Boats

Every hunter in Ukiuk went on winter sealing expeditions; almost every man bagged one or two (page 137). The author, a graduate of Arizona School of Mines, taught in the big white school in the center. Ukiuk's church perches at upper right. Household waste mounds the snow below the silt-legged houses. Fresh water comes from clean surfaces higher on the cliff. Offshore ice served as a baseball field for boys.



Hunters Bag a Rare Prize, a Beluga, or White Whale

King Islanders harpoon only one or two whales in a season. They eat the savory skin and a layer of blubber (page 140). Lean meat they feed to the dogs. The Arctic Ocean's white whales migrate as far south as Cook Inlet. Only adults are entirely white; newborn calves are gray.

the herd had been sighted. Now there was no mistaking the thunderous bellowing.

Paddling slowly and quietly through the ice field, we rounded a large cake of ice and suddenly came within sight of the beasts. Without a sound the crew pulled the boat onto the ice pan. A herd of nearly 300 walrus was on the immense sheet, not more than 100 yards from us.

The stalk began. Sneaking over the ice and occasionally taking cover behind low ridges and snowdrifts, we moved undetected to within 20 feet of our quarry. The hunters then strung out in a line and, at a shouted signal from the captain, stood upright and started shooting.

The walrus, taken completely by surprise, heaved their massive bodies across the ice toward the safety of near-by water. Some never made it; others did, only to be shot before they could dive or swim away. The shooting, the shouting of the men, and the

bellowing of the walrus lasted perhaps 10 minutes.

When the wounded animals had been dispatched by shots through the head, I looked around me. Huge carcasses dotted the ice like small, dark islands. Others floated lifelessly in the water (page 136).

Now the real work began. The carcasses had to be skinned and butchered, the valuable ivory removed from the massive skulls, and all loaded into the boats.

Six hours later we were ready to start home. Our umiaks were filled with meat and ivory. The island was a dot on the horizon; we were more than 20 miles from the village. For the first time that day I looked at my watch; it was after midnight. The hunt had lasted nearly 24 hours.

In the middle of May the murrets arrived. During the day the birds went out to sea to feed, returning to their rocky perches at night. Soon the auklets and puffins came. When



146

What Short Teeth You Have, Grandma!

Chewing sealkins for soft footwear has worn this woman's teeth nearly to the gums. Following the birth of her first child, blue lines were tattooed on her chin. Today the custom is no longer practiced.

we went for walks along the sides of the island or climbed the steep cliffs, birds flew around us like swarms of bees.

Birds and Eggs Supplement Diet

The birds were shot or caught in nets and ordinary steel-jaw traps. Hunting was carried on mainly during the short, dusky nights. Early in the morning we often saw a tired family scrambling down over the cliffs to the village, carrying 50 or more auklets. Some had been caught by children with a noose.

These birds, together with their eggs, provide an important addition to the villagers' diet. Eggs can be kept for a considerable time in the ice cave. We found the meat of the birds, particularly that of the auklet, delectable.

The sandhill crane, snow goose, and a variety of ducks visit the island briefly in the spring and then move northward.

One morning in mid-June, we awoke to find the sun masked by thick black clouds. The sea churned into a mass of spray and foam; the last of the ice tore loose from shore.

"No more ice," the villagers sadly announced. "We go to Nome when storm over."

No more ice meant no more walrus. There was no further reason to stay. Now was the time to hurry to Nome for summer jobs.

We knew that as soon as the village leaders thought the storm was over, we would leave, with perhaps only a few hours' notice. The 35-mile trip across open ocean from the island to the nearest point of the mainland was risky at best. Fair weather and a calm sea were necessary, for the skin boats would be heavily laden with Eskimos and their goods.

Everyone Goes but the Dogs

Finally everyone was ready. We sat and waited for three days. Every few hours the captains of the umiaks climbed to the highest part of the island and looked toward the mainland.

At last the word came down: "Get everything into the boats. We leave tonight!"

Men, women, and children staggered down the steps under loads of meat, blubber, and household goods and loaded them into the

boats. The piles grew higher and higher. I wondered how the people would possibly find room for themselves.

Still they continued to load, until some of the boats had barely three inches of free-board. Then paddles were fastened in an upright position to the gunwales of the umiaks, and canvas sides were strung up over them to keep out the ocean swells.

At a signal, everyone climbed into the boats and we chugged out to sea. As we left, the island's heartbroken dogs lined up on the beach and howled mournfully. I shall never forget that dismal serenade of nearly a hundred dogs, all howling at once.

The noise of the dogs and the outboard motors frightened thousands of birds from their nests in the cliffs. The sky was literally blackened as the flocks circled over our heads.

As the six umiaks rounded a corner of the island, the village vanished from sight. A fresh evening breeze whipped our faces. We shrank down into our parkas for warmth; Nome was 13 hours away. Our winter on King Island was a thing of the past.

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The National Geographic Society and the Royal Ontario Museum in 1951 explored and measured newly found Chukchi culture graves, 11,000 feet in diameter, in northern Quebec.

The Society and individual members contributed \$100,000 to help preserve for the American people the forest of California's sequoias, the Giant Forest in Sequoia National Park.

One of the world's largest arctic and glacial systems outside the polar regions was discovered in Alaska and Yukon by Bradford Washburn while exploring for The Society and the Harvard Institute of Exploration in 1936.

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Despite the increased chances for respiratory illness during the winter, there are many things you can do to help ward this off—or if it does occur, to prevent complications and hasten recovery. Here are some good hints for winter health which you may wisely follow.

1. Build up your resistance. Respiratory infections are most likely to strike when a person is "run down" or "tired out." So, it is wise to get plenty of rest and sleep, take some exercise, and dress warmly to avoid becoming chilled.

2. Do not be careless about colds. If you get a cold, and have a fever, it is usually advisable to stay at home for a day or two. Rest in bed if you can. Keep warm and eat lightly. *If fever persists or is unduly high, call the doctor without delay.*

3. Give yourself plenty of time to recover. Medicines which the doctor prescribes may send the fever down rather quickly and make you feel much better, but this should not be a signal to get up immediately.

You may run the risk of weakening your body's ability to continue the fight against the invading "germs" if you get up too soon. All too often this results in a relapse which may be more serious than

your original trouble.

4. Have a physical examination. If you have "one cold after another," suffer from repeated sore throats, or are bothered by a chronic sinus condition, it would be wise to see your doctor for a thorough health examination. He may find conditions that can be easily corrected—or he may suggest measures that can help you go through the winter in much better health than ever before.



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